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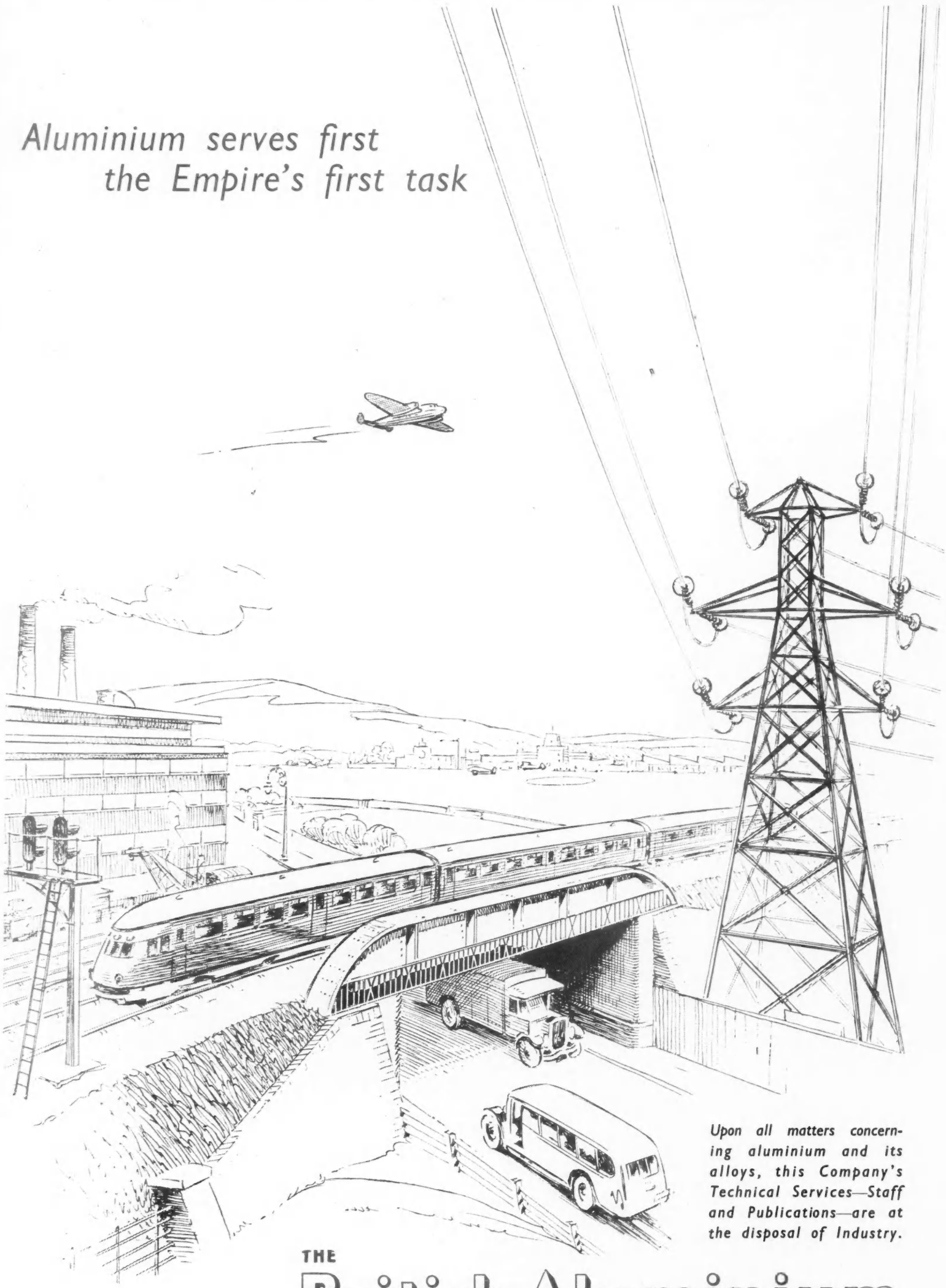

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A Seven-Day Journal

New Anglo-French Trade Agreement

THE Board of Trade announces that the Governments of the United Kingdom and of France have agreed that effect should be given to the conclusions recently reached by the President of the Board of Trade and the French Minister of Commerce with a view to promoting the favourable development of Anglo-French trade. The understanding reached involves, as regards the mutual trade of the two countries, a considerable relaxation of the measures of prohibition and restriction which each was obliged to impose at the outbreak of war. The arrangements now agreed upon follow logically from the provisions of the Financial Agreement made on December 4th, 1939. Substantial progress has also been made in the recent exchanges of views towards the realisation of the same object in relation to other parts of the British and French Empires. At the same time, competent authorities of the two countries have agreed on steps to simplify to the greatest possible extent present formalities relating particularly to the control of external trade and of the movement of private persons, and to postal, telegraphic, and telephonic communications. These administrative measures are intended to allow full advantage to be taken of the opportunities for the trade of both countries presented by the new arrangements. Finally, the representatives of the two Governments have jointly examined the means for overcoming difficulties standing in the way of a parallel development of their export trade. In this connection they have approved the forthcoming discussions in London between the Federation of British Industries and the corresponding French federation, which are designed to facilitate contacts between the corresponding exporting industries of the two countries. These discussions and their results, as a whole, serve to emphasise the desire for full and close collaboration between the two countries, such as will not only contribute to their strength in present circumstances but will also form a potent factor in post-war economic reconstruction.

Aircraft Exhibition at the Science Museum

The Science Museum, South Kensington, has reopened a portion of its ground-floor galleries, and has arranged in the Main Hall of the building an exhibition illustrating "Aircraft in Peace and War." The exhibition is divided into four sections, the first dealing with the years 1903–14 and consisting chiefly of a series of models of historic aircraft, beginning with the Wrights' aeroplane of 1903, all one-tenth full size. The Wrights' original machine is also on view. Next follows a series of models of the period of the Great War, 1914–18, representing the machines both of the Allies and of Germany, among them the Vickers fighter biplane of 1914, the Fokker, and the Handley Page biplane, type V/1500, of 1918, one of the earliest of the long-range heavy bombers. The third section shows, again by means of models, the development of civil and military aircraft throughout the world during the years 1919–39; and the last section illustrates, one-fourteenth full size, various machines used by the R.A.F. in 1940. These last-mentioned aircraft include the latest type of all, the Bristol "Beaufort," and the "Wellington" bomber, which has been widely used for leaflet raids, bombing enemy warships, and so on. An actual example of the engines used in the last-named machine, a Bristol "Pegasus," is on view, as well as a Bristol "Taurus." Two Napier engines, the "Rapier" and the "Dagger," are also exhibited. Photographs form another feature of the display, and there is an interesting series which teaches the visitor how to distinguish various kinds of machines when they are seen overhead. Other parts of the Science Museum which are reopening are No. 1 Gallery, with a display of carriages and other forms of transport, the Locomotive Gallery, and the Children's Gallery, which will also serve as a refuge in case of air raids.

Fuel for Omnibus Services

ON Thursday, February 15th, the annual general meeting of Thomas Tilling, Ltd., was held. Mr. John F. Heaton, chairman and managing director, presided. Referring to the effects of the war upon the company's services, he said that the most important of them had been occasioned through the rationing of fuel supplies and the consequent curtailment of omnibus services. He expressed the hope that the present supplies of fuel would not be further reduced except in the case of dire necessity, as the work which the companies were doing was of great importance to the community. The question of alternative fuels had been under consideration for more than a year. Experiments had been carried out by the company's organisations with encouraging results, so much so that certain types of omnibus services were now being regularly operated by vehicles converted to the use of producer gas obtained from anthracite. Some loss of power was experienced in comparison with vehicles operated by fuel oil or petrol, and in the company's organisations as they existed at that date additional servicing costs were incurred. They were, however, gradually effecting improvements, to such an extent that it was thought ultimately to be practicable to design a special engine for that purpose. So far as the present emergency was concerned, at the company's Bristol works there had been in hand since before the war the materials for manufacturing approximately 600 producer plants, and as it would be wrong to sit back and complacently anticipate that supplies of imported fuel would continue to be available in existing quantities, the manufacture of that number had been put in hand. They would not go far in the company's organisation, but in case of need the number could be added to, provided the supply of raw materials were available. It would be only in a period of greater emergency, however, that any really substantial change-over would be contemplated. He added that with a good deal of foresight the Government some long time ago had set up a committee to investigate the possibility of producer gas as an alternative to the fuels more commonly used, and that the thanks of users of commercial vehicles generally were due to the Ministry of Mines for the excellent work which had been done. The Government committee to which reference was made by Mr. Heaton was presided over by Sir Harold Hartley, and the publication of its report was recorded in a Journal note in our issue of February 9th.

The Bletchley Train Accident

LIEUT.-COLONEL A. H. L. MOUNT, the Ministry of Transport Inspector, in his report on the train accident at Bletchley, Bucks, last October, in which four lives were lost, states that the accident was caused by the failure of the driver to observe and act upon danger signals. He points out that the accident was noteworthy as being the first under blackout conditions to result in serious consequences. Although the driver's conduct could not be excused, his failure merited consideration on account of the difficult prevailing conditions, which called for clear thinking and more intimate knowledge of the road than the driver possessed. It will be recalled that the driver blamed was in charge of the pilot engine of the 7.50 p.m. express from Euston to Stranraer, which struck the 7.37 Euston to Inverness express standing in Bletchley station. Behind the pilot engine was the train engine, whose driver also failed to observe the warning indication of the Bletchley distant signal and the danger indications of the outer and inner home signals. A speed restriction of 60 m.p.h., which was alleged to have been infringed, was in force. Colonel Mount says that a colour light distant signal might have had preventive effect, while automatic train control of the warning type would certainly have ensured obedience to signals on that occasion. He added that he understood that both those important adjuncts to safety were being introduced on that main line when war was declared, but work on the latter, which was of an experimental nature for test purposes at high speeds, had been suspended, having regard to reduction in maximum speed to 60 m.p.h. He felt, however, that the driver's difficulties might be so much enhanced under blackout conditions, and that integrity of operation was so important on a main line such as that, that the extension of automatic train control equipment should be actively pursued again so far as labour and materials permitted.

Aircraft Manufacture in War Time

ON Monday, February 20th, Mr. A. S. Butler, chairman of the De Havilland Aircraft Company, Ltd., presided at the firm's annual general meeting. He reported, with regard to sub-contracting work, that the aircraft, engine, and airscrew divisions and also the flying schools had all been working to capacity in the national interest. He thought that the firm could be justly proud that its organisation, normally engaged very largely on civil work, had been able to throw its weight so effectively into the service of its country. At the request of the Air Ministry its programme in all divisions had been assisted by the employment of sub-contractors, and while that had undoubtedly enabled it to achieve a far greater output than would otherwise have been possible, it had thrown much additional work on many members of its organisation. In that respect it was often easier to do a job of work oneself than to have to show someone else how to do it. With regard to production, the manufacture of the "Moth Minor," which had been showing much promise, had had to be abandoned at the firm's works in order to liberate space and personnel for the war programme. But the whole of the finished and unfinished stocks had been shipped to the company's Australian factory, where production of the type was to continue for use as basic trainers. The first "Flamingo" had gone successfully into service with Jersey Airways during last summer and this same aircraft was now on his Majesty's service. A steady production programme of this type was proceeding. The "Albatross" had been in operation with Imperial Airways and British Airways for over a year, and had proved to be the fastest machine on British commercial operations. Many thousands of "Gipsy" engines had been built. Overseas companies were in operation in New Zealand, Australia, Canada, and South Africa, and were busily at work. Civil aviation had, of course, to take second place to Service requirements, although a considerable export business was necessary and had been carried out. But all demands from overseas markets had not been met, and it was essential to gain these markets in the face of neutral competition, especially the markets lost by Germany in civil aviation.

Export Trade and Labour Requirements

IN a speech at Nottingham on Saturday, February 17th, Sir Samuel Hoare, Lord Privy Seal, urged the importance of maintaining our export trade, and said that we must economise in labour and in the products of labour. We must direct the energies of our working men and women to producing goods for the service of foreign markets instead of the supply of home demands. It might be said that there was no need to economise in labour so long as we have 1,361,000 unemployed in Britain. But that figure did not represent the real unemployment figure in Britain. It was a misleading total. Mr. Ernest Brown, the Minister of Labour, had shown that when casual workers were deducted, when account was taken of men passing from one job to another, and when other adjustments were made, the real total of those in this country immediately available for work was very much less. Our reserve of immediately available man-power in the labour market was probably not half the total number. That reserve was a very small percentage of the men and women now at work. It was a very small reserve. All the men in it should find their way into productive work before long. There had been great changes in the field of employment. Whole classes of excellent citizens, and particularly great numbers of the black-coated workers, had lost their jobs as the result of the changes that were inevitable in war-time. He said to those men and women: "Though your old job may have gone, go to the employment exchange and find out whether there is not a chance for you in some other branch of work, and whether, in particular, it would not be wise for you to have a training course in work that is urgently needed by the State." There was nothing derogatory to anyone in asking for this information. Thus, taking those things into account, we had no need to consider unemployment as a factor standing in the way of our decision to economise in our use of labour. For unemployment was already passing from the nation's life as an urgent and overshadowing problem.

The Institution of Mechanical Engineers

THE Annual Report of the Council of the Institution of Mechanical Engineers was presented on Friday, February 16th, at 2.30 p.m. at a General Meeting at Storey's Gate. The result of the ballot for the Members of the Council was also declared. The names of the Members elected are as follows:—Asa Binns, President; Mr. Sterry B. Freeman, and Professor F. C. Lea, Vice-Presidents; Lord Dudley G. Gordon, Major Wm. Gregson, Mr. F. W. Hawksworth, Mr. H. R. Ricardo, Mr. A. J. Grant, Mr. A. C. Hartley, and Mr. B. W. Pendred, Members of Council. At the request of the President, Mr. Gregson made an earnest plea for the Benevolent Fund, in which he pointed out that if all members made only a small addition to their subscriptions a handsome capital fund would be rapidly built up. From the annual report it appears that the total membership of the Institution is now 13,679, of which over 3000 are full members and nearly 6800 associate members. The balance sheet shows that the finances of the Institution are in a satisfactory condition. After the conclusion of the formal business, the prizes were distributed. The President, Mr. E. Bruce Ball, then read an address, which is reprinted elsewhere in this issue. This innovation was a result of the war, which caused the postponement of the delivery from October, as usual, till the present time. On the conclusion of the address Mr. Bruce Ball retired from the chair and the new President, Mr. Asa Binns, occupied it. A double vote of thanks to the retiring President for his great services to the Institution in a difficult year of office, and for the charming address which he had just delivered was then proposed by Mr. Loughnan Pendred and seconded by Dr. Mellanby. The next meeting will be held on March 1st at the usual hour, 6 o'clock, when a paper on "The Circulation of Water and Steam in Water-tube Boilers and the Rational Simplification of Boiler Design" will be read by W. Yorath Lewis and S. A. Roberts.

New York Municipal Airport

No. I

MUNICIPAL Airport No. 2 of the City of New York, which for some time was known as the North Beach Airport but more recently designated as LaGuardia Field, was officially declared open for service just after midnight of December 1st, 1939. The ceremony marked the climax of construction work that began early in September 1937. As LaGuardia Field stands at present, it has cost, it is estimated, quite $40,000,000. A large part of this outlay resulted from the expense involved in transforming a shallow watery waste into a land area, requiring the transportation and placing of 17,300,000 cubic yards of fill.

The fundamental reason for creating LaGuardia Field was a civic desire to give the municipality an aviation base at a focal point within the greater city for the operation of both landplanes and seaplanes. Heretofore, the commercial landplane and seaplane companies serving the metropolis have had their terminal points at widely separated places—the seaplanes using Port Washington, on the northwest shore of Long Island, and the majority of landplanes, carrying mail and passengers, arriving and departing from the Newark Airport in New Jersey. The situation then existing did not make for the convenience of the public nor the efficient co-ordination of the two types of services. The situation chosen for Municipal Airport No. 2 of the City of New York was believed to offer the most satisfactory solution of a problem that was becoming more and more pressing.

The municipality, because of its situation on the Atlantic seaboard, is logically a central point for aviation service on a big and wide scale; and, like all populous communities with diversified interests there is a section of the city where many of these activities are especially concentrated. In the City of New York this is what is known as the Grand Central Zone, within which lie the principal railway terminals, most of the leading hotels, many business institutions, theatres, &c. In seeking a site for Municipal Airport No. 2, the aim was to find one that would be reasonably close to the Grand Central Zone and readily accessible because of existing highways or other routes in process of construction that could be used by motor vehicles travelling at good speed.

North Beach, on the East River shore of the Borough of Queens, was selected for development because it offered all that was desired for a base for both landplanes and seaplanes. The aim was to create a transfer point for trans-continental and trans-oceanic air travel. LaGuardia Field was, therefore, designed and has been equipped so that passengers may there make the single change necessary for flight between all parts of the United States and Europe or Bermuda. From the same field services can be maintained with Miami, Florida, where the traveller may connect with aircraft bound to and from the West Indies and Central and South America. The field is only ten minutes distant by motor car from the Triborough Bridge via the Grand Central Parkway; and as soon as the East River Drive, now under construction, is completed, the air base will be but twenty minutes away from the Grand Central Zone of the Borough of Manhattan—the heart of the City of New York.

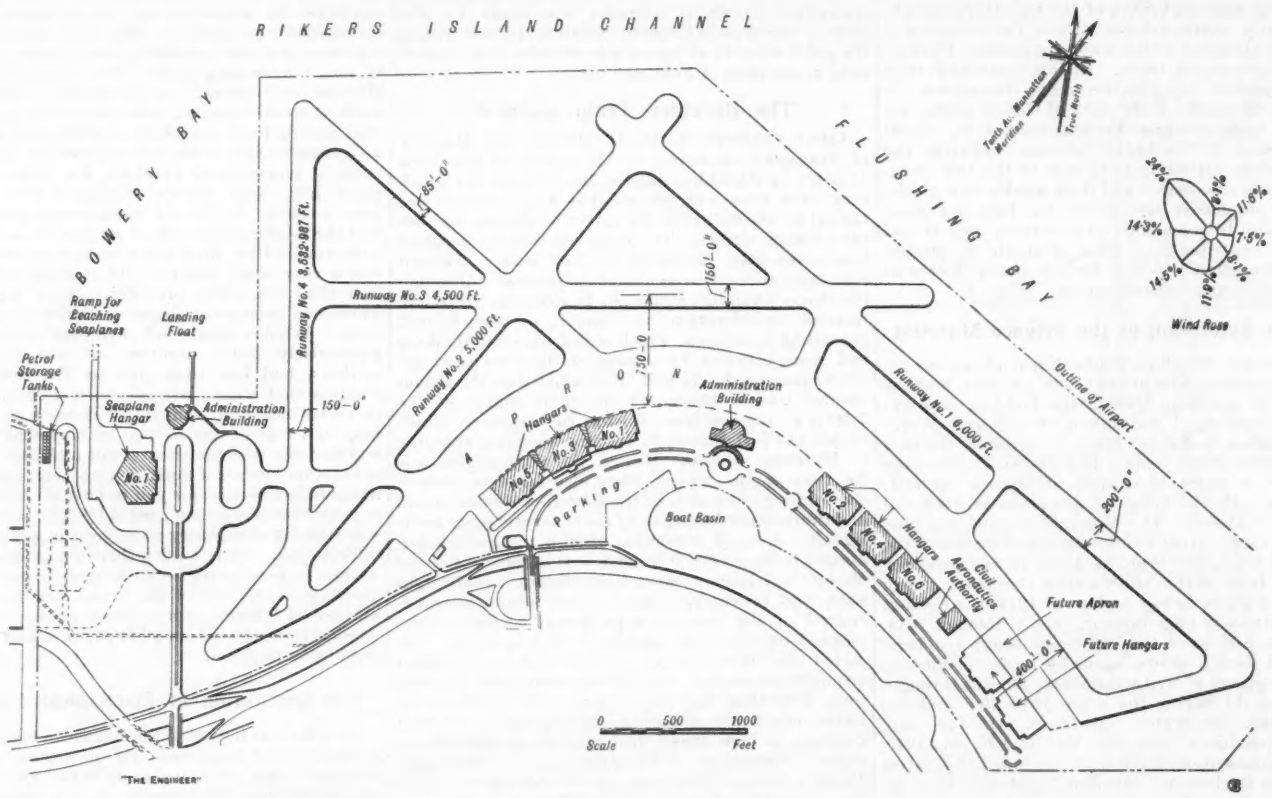
It may be of interest to recall that a section of the original land now forming part of LaGuardia Field was a small and privately owned air field as recently as 1929, which was operated for some years as the Glenn H. Curtiss Air Terminal. The property was leased by the city in January, 1935, and at that time the area totalled 105 acres and was situated on a peninsula jutting out into the East River where it was flanked on the west by Bowery Bay and on the east by Flushing Bay. At that time the field was devoid of runways as the term is now understood, and near the northwestern border of the property there were three small hangars of the simplest types. While the city's tenure was that of a lessee, with an option to purchase, the field was used by private aircraft owners as a base for short sight-seeing trips.

Rudimentary as North Beach seemed a few years back as a possible site for a modern municipal airport, still the area offered the opportunity for reclaiming from the East River a large tract of land through filling operations so that an airport of adequate size could be created. Without restrictions of hampering surroundings and neighbouring buildings, it was manifest that the site would permit of an arrangement of runways of the fullest required lengths in relation to the prevailing winds of the region. Furthermore, arriving aircraft could make their approach over water and be able to lose altitude at a good distance from the field. Finally, by situating the flying field adjacent to the shore, and grouping the airport hangars and administration buildings inland, the best disposition of the various features could be assured.

When approval for the undertaking had been obtained from the civil authorities in 1937 and financial aid had been guaranteed by the Federal Government, through the Works Projects Administration, the existing property was purchased and the preparation of plans started. The best advice was sought in the laying out of the airport and extensive soil borings were made over the entire area to be utilised, both on land and under water, where filling was to bring up the ground surface to an acceptable general elevation above mean low water. Construction work was begun on September 9th, 1937, when the first dipperful of soil was dug by one of the numerous power shovels used on the job.

The original plan was to increase the 105 acres of the existing field by the purchase of 96 acres of adjoining land and by filling out into Bowery Bay, the East River and Flushing Bay so as to produce a field having a total area of 429 acres. Subsequently, in order to provide runways of greater length, the plan was modified and the area increased to 558 acres—of which 357 acres were to occupy areas previously under water. The volume of fill required thus became 17,300,000 cubic yards instead of the 9,300,000 cubic yards called for in the first place. Some of the required fill could be obtained by razing a low hill at one of the inner corners of the property, but by far the major volume would have to come from exterior sources. Happily, Riker's Island, lying out in the East River, offered an abundance of material for the purpose. Incidentally, Riker's Island could be transformed from an eyesore into a landscaped area of agreeable appearance. Riker's Island, for more than 50 years, had been used by the Department of Sanitation as a dump for cinders, ashes, and miscellaneous rubbish. Some of the hills so formed had a height of fully 100ft., and many of them were smouldering masses dissipating malodorous smoke and fumes.

After considering various ways of making the fill, the engineers decided that it would be more economical and more satisfactory to raze the mounds on Riker's Island with power shovels and then transport the excavated material to the site of the airport. The primary problem was how best to move the material across the intervening Riker's Island channel—a waterway much used by barges and other lesser types of craft frequenting the East River. A solution was found in a trestle 2280ft. long and 24ft. wide built across the channel. The trestle consisted of steel stringers supported on steel H-beam piles, carrying a wooden deck that provided for two lanes of traffic. The channelway was occupied by a floating swing span of steel—a scow-like structure 240ft. long that weighed 300 tons. The span was hinged at one corner through a bracket to a pipe pile 24in. in diameter that was driven outside an anchoring H-beam pile; the span was opened and



GENERAL PLAN OF AIRPORT

closed by electric winches pulling on wire cables, each of which was anchored at one end. Transfer spans or ramps at each end of the swing span linked the swing span with the trestle when the crossing was closed to river traffic. When the channelway was cleared for shipping, the ramps were raised out of the way of passing vessels.

At the peak of the operations, excavating and loading was done on Riker's Island by a group of 40 power shovels served by 400 lorries. The mounds on the island were successively lowered by cuts 15ft. in depth, levelled off at the grade and then another 15ft. cut was started. The excavated material was loaded almost continuously

POWER SHOVELS AND MOTOR LORRIES ON RIKER'S ISLAND

throughout the working days of 24 hours. The haulage schedules called for the moving of an 8 cubic yard load every seven seconds over the river crossing. The filling of the reclaimed area was begun at each section at low tide and built up as the water rose. The lorries dumped along the shore line and the fill was spread outward by Caterpillar bulldozers. By the time any given section was thus brought up to the grade, the movements of the lorries and bulldozers had sufficed to pack the fill to a stable condition. The fill was spread in a succession of thin blankets, and while doing the work a flat slope of 35 : 1 was maintained. The maximum settlement of the fill

TRESTLE ACROSS RIKER'S ISLAND CHANNEL

during the construction period was about 8ft., and occurred while the motor lorries and bulldozers were applying pressure. The outer edges of the fill disappear under water on a slope of 20 : 1, which is believed ample to withstand wave action at the site.

The only bulkhead along the waterfront of the airport is at the westernmost shore line flanking the seaplane base, where the projecting landing float and ramp have required a dredged area 15ft. deep. The bulkhead has a length of 1763ft. and was constructed of steel sheet piling. The general level of the airport is at 12ft. above mean low water at the perimeter and 15ft. at the front of the various buildings inshore. This reclamation has required in places a maximum depth of fill of about 27ft., inclusive of displacement of the underlying silt and incidental settlement.

In order that the airport may serve the twofold function of a terminal for trans-continental and for trans-oceanic aircraft, the reservation contains two separate bases, and each base has its own administration building and hangars. The two bases are linked by a taxi runway for aircraft and by an interior road that borders the Grand Central Parkway. There are four runways for landplanes, each with a surface of five-course asphalt macadam intended to adapt itself to any settlement that may take place in the ground beneath it. The longest of these runways, No. 1, is 6000ft. long and 200ft. wide, and runs north-west and south-east. Runway No. 2, laid out on a north-east-south-west line, is 5000ft. long and 200ft. wide. Runway No. 3, laid out on an east and west course, is 4500ft. long and 150ft. wide. Runway No. 4 extends north and south, and is 3552 ft. long and 150ft. wide. The runways were designed in accordance with data obtained from meteorological records of the prevailing winds at the site. The 6000ft. runway was laid out on the line of direction of the most frequently prevailing winds; and the succeeding runways, with gradually diminishing length, were planned to meet the winds of relatively less frequent occurrence.

Taxi runways, 100ft. wide, intersect the main runways so as to connect them with one another and with the apron in front of the landplane hangars and the Administration Building. The apron is 400ft. wide and 6200ft. long. For a length of 2500ft., where the apron rests on the original ground of the site, it is paved with concrete, and where the remainder of the apron occupies newly made ground, the surfacing is of asphalt macadam similar to that on the runways. That part of the apron which is in front of the loading platform, which is centrally situated between the two groups of hangars and is 1500ft. long, is intended to provide ample space for the simultaneous loading or unloading of fifteen of the largest transport aircraft. The entire ground area of the airport, except runways, apron, roads, and parking spaces is top-soiled and seeded to grass, and much of the area on the Parkway side of the reservation is still undergoing development to increase the attractiveness of the field. Across the grass plots between the runways, 85ft. letters of white crushed stone spell "New York" as a guide for the airmen aloft.

The administration building at the landplane base overlooks a boat basin, maintained by the Department of Parks, that lies between the south-eastern part of the airport and Grand Central Parkway. The basin connects by a narrow channel with Flushing Bay. Between the Grand Central Parkway and the buildings of the landplane base there is a macadamised parking space that can accommodate 1600 motor cars. The buildings of the landplane base comprise the administration building, corresponding in its function to a large railway terminal, and six hangars, all arranged on an arc that has its convex side toward the field. That arrangement harmonises with that of the runways which was prescribed by the Government bureau now known as the Civil aeronautics Authority. The master plan of the airport provides later for two more hangars of dimensions similar to those of the hangars now in service. The various buildings are supported on cast-in-place concrete piles that have lengths of from 35ft. to 125ft. The structures that are set on the original ground have only their columns resting on the

CONTROL TOWER

concrete piles, but the buildings that rise from the filled area—the structures of the eastern group—have both their columns and their base concrete floor supported by the piles. All told, more than 9000 concrete piles were used. All buildings are of fireproof construction throughout, and have steel frames with exterior walls of buff coloured brick.

The landplane administration building is rectangular in plan, 300ft. long by 60ft. wide, and has two stories and a basement floor above ground. There is a circular section, one story higher and 170ft. in diameter, centrally placed and extending toward the landing field. Within this section there is a rotunda, 90ft. 6in. in diameter, and here are situated the ticket offices of the various airlines, a large circular information desk, and various other conveniences required for travellers and those seeing them off or awaiting their arrival. Behind the ticket offices are quarters for pilots and offices for the operating personnel. In one wing of the second floor of the rectangular part of the building there is a coffee shop and kitchen, and in the opposite wing are offices for the airport manager and his staff. On the same floor there is a commodious lounge, and beyond that there is an extensive sheltered observation area which affords a view of the entire landing field.

On the first floor, in addition to certain offices and a large dining room, there are a post office, baggage, and express rooms, &c. On the topmost floor, the U.S. Weather Bureau, and two departments of the Civic Aeronautics Authority, the Air Traffic Communications, and the Air Traffic Control are situated; from these offices all air traffic in the north-eastern part of the United States may be handled. On the roof of the circular section of the administration building of the landplane terminal, 64ft. above ground, is a steel and copper control tower, with sides

sloping outward at the bottom to prevent reflected glare. Its upper part is designed to shield the windows from water in time of storm; and it is equipped with special air-conditioning apparatus to prevent condensation on the windows. Out of the tower there is a rotating beacon of a new double-end type, of 13,500,000 candle power. Also, on the roof of the tower are the latest types of wind velocity and direction indicators. These instruments operate seven sets of indicators for the control tower operator and repeaters in the hangars of the various airlines. The control tower, like the loading platform and the various operating and administration offices, is connected by pneumatic-tube service for the transmission of reports and orders.

Access to the aircraft is obtained from a covered platform of concrete construction 1500ft. long and 20ft. wide. This platform runs along the inner edge of the loading apron and connects the two groups of hangars, with the administration building in the centre. The field side of the platform is enclosed by steel panels with forty swing doors or gates spaced at convenient intervals. These gates are divided into groups of three by dispatchers' booths which connect with the dispatchers' office and ticket offices inside the administration building both by pneumatic tubes and telephones. The latest information on weather conditions and the final check-up of passenger tickets are given at the booths. A public address system announces the arrival and departure of aircraft. The aircraft are brought up to their respective gates of the platform where passengers can embark or disembark only a few feet away from the gates. Stairways lead down from the concourse of the main floor of the administration building to the covered platform; and other broad stairways lead from the concourse on to the concrete promenade on top of the loading platform. This promenade affords accommodation for persons seeing travellers off or awaiting their arrival; and from it the entire spread of the airport lies before a spectator while he remains safely out of the way of the aircraft. The platform can accommodate 5000 people.

The six landplane hangars are identical in size and appearance. Each is 350ft. wide by 165ft. deep and has a height of 42ft. from ground level to the under side of the roof trusses. The three hangars that have been leased by the American Airlines have been connected for convenience in operating them as a single unit. At the Parkway side of these associated structures there is a two-storey wing, approximately 1300ft. long, that runs the length of the hangars, and has a width of from 40ft. to 60ft. The first floor houses a kitchen in which food is prepared for passengers on the American Airlines machines and the employees; and on the same floor there are a commissary department, pilots' training facilities, pilots' and stewardesses' lounges, shops, stockrooms, hospital, and offices. The second floor is occupied by offices and a cafeteria for employees. On the control rooms for testing engines after overhauling. The second floor has shops for instrument and radio overhaul and a lunch room. Air-conditioning equipment has been installed in the office section of the American Airlines group, and the installation comprises twenty-two machines and 300 tons of refrigerating units. Similar wings, with machine shops on the ground floor and offices above, are provided for the hangars which constitute the easterly group of the landplane terminal.

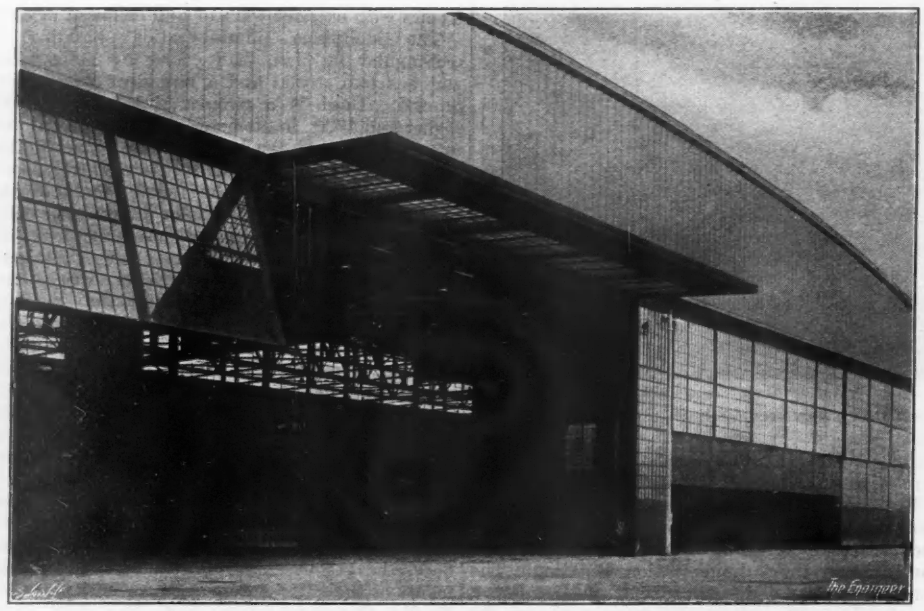
The field side of each unit of the landplane hangar groups is enclosed by four electrically operated steel-and-glass doors. The doors are hung in pairs on the two sides of a single steel pillar set in the middle of the façade opening. This pillar is the only obstruction in that opening, and there is a clear space on either side of 163ft. 5in. Each door is in two horizontal sections—an upper and a lower section. When opening one of these doors, the lower section rises just behind the upper half until the two bottom edges are even, which affords an opening 21ft. high; but, if so desired, the two sections in the foregoing relationship can be swung together outward and upward to provide an underclearance of 40ft. The doors are controlled through simple electric switches, but they may in case of emergency be operated by hand—a system of counterbalances making this possible. The exterior space between the top of the doors and the flat curve of the roof is covered with stainless steel. The corresponding space at the rearward side of the building, between the roof of the two-story wing and the hangar, takes the form of a huge window glazed with a blue glass that reduces glare and also lessens the transmission of heat from sunlight striking the southern exposure.

The landplane hangars are heated by individual hot-air systems, the heated air being blown from furnaces in the office wings through concrete tunnels, about 4ft. square, around the sides and across the opening of a hangar. A concrete trench across the opening, just inside the doors, receives the heat from the tunnel and discharges it upward through subway gratings. The furnaces and fans are so connected electrically with the doors that, when the doors are raised, the flow of heated air is automatically accelerated, and this action creates an upward moving wall of warm air to counteract any cold air that tends to enter the hangar through the opening. Outlets along the closed sides of a hangar are also connected with the hot-air tunnel system. The office and machine shop wings of the hangars in the American Airlines group are heated by steam, and the steam is distributed by an 8in. main. The three boilers that furnish the steam are in hangar No. 5. In hangars Nos. 2, 4, and 6, the office and machine shop wings as well as the hangars proper are heated by hot air. This is also the case throughout the seaplane hangar at the south-western section of the reservation. Altogether there are thirty hot-air furnaces in the seven existing hangars; and all furnaces at the airport are oil-fired. The fuel is stored in two 15,000-gallon underground storage tanks on the Parkway side of each building; and the oil is delivered to the tanks by trucks.

The interior of each hangar is lit from 56 fixtures suspended from the trusses. Half the fixtures are equipped with 750-watt "Mazda" lamps, and the other half are of a mercury-vapour type of 400 watts. The combination closely resembles daylight. The lighting is controlled by remote-control switches at the doors and at the rear of each hangar. It is possible to turn on all 56 lights at once by means of only three switches. Fluorescent lights are provided in the workshops because of their high candle power. In some of the shops the lighting fixtures are suspended from trolley ducts so that they can be moved about readily to meet changing situations. Electric outlets in the hangar floors afford convenient means of testing electrical connections on the aircraft.

In addition to the accompanying engravings three views of the airport will be found on page 184.

(To be continued)



HANGAR WITH DOORS OPEN

The Resistance of Copper to Soil Corrosion

By H. G. TAYLOR, M.Sc. (Eng.), F.Inst.P.*

No. II

(Continued from page 158, Feb. 16th)

MODERN EXPERIENCE WITH BURIED COPPER

Gas Pipes in America.—The use of buried copper gas pipes on a large scale appears to have been commenced in America in 1926 by the Southern Counties Gas Company, of California, and by the Richmond, Virginia, Gas undertaking. The Cincinnati Union Gas and Electric Company started experiments on copper services in 1929, and has since developed the practice very considerably. This company was followed by the Baltimore Gas Company and others. By 1939 the number of undertakings burying copper pipes underground had grown considerably and all were satisfied that the increased resistance to soil corrosion and the absence of internal rusting were well worth while. It is not known how many companies are using copper gas pipes at the present time, but the following information will show that they are used to a very large extent by some companies.

Southern Counties Gas Company, California.—Copper pipe in use at May 31st, 1939:—

Services	29,468	Totalling 705,000ft.*
Mains—		
¾in., 1in., 1¼in., 1½in., and 2½in.	62,477 ft.	Totalling 629,431ft.†
2in.	490,388 ft.	
3in.	76,566 ft.	

* Estimated from known average length of services. Two-thirds of these services have been installed during the last four years.

† More than half this total has been installed during the last four years.

The Baltimore Gas Company.—New copper services installed at the rate of 5000 to 6000 yearly in addition to 15 to 20 replacements daily of iron pipes by copper pipes.

Richmond (Virginia) Gas Undertaking.—Copper used for all new installations.

Cincinnati Gas and Electric Company.—75 per cent. of service pipes in copper, 25 per cent. in steel. 385,037ft. of copper service pipes installed up to August 1st, 1939.

In 1935 the Southern Counties Gas Company of California had had nearly nine years of experience with copper pipes underground in many different soils, including adobe, alkali bottoms, salt marshes, and submarine crossings. The copper lines are connected at many points to steel or cast iron lines. Some of the pipes which had been installed for nine years were in soil where previously 2in. steel pipe protected with a hot asphalt coating lasted considerably less time. In 1935 the company had not found a case where appreciable corrosion of copper had taken place, and had found no case

* Copper Development Association.

where accelerated corrosion of steel or cast iron pipes connected to the copper pipes had occurred. These observations were based mainly on the inspection of short lengths of pipe for reasons other than corrosion and on occasions several hundred feet of pipe had been removed for other reasons, thus providing excellent opportunities for studying the conditions of pipes buried in corrosive soil.

A 3in. copper submarine pipe line across Newport harbour was a case of this type. This line was 988ft. long and was installed in 1928 in a dredged trench at the bottom of the harbour. It was necessary to remove this line in 1935 for dredging operations, and the whole pipe, including the sections at the end, alternately submerged and exposed by the tides, was found to be in excellent condition.

Many cost comparisons have been made by gas companies based on an estimated life for copper varying from 30 years to over 100 years, and whilst it would serve no useful purpose to give all the details in view of the variation in cost of labour and material, it is important to note that all are agreed that in the long run a substantial saving can be effected by using copper—largely owing to the reduction of the heavy cost of digging up and reinstating pavements and road surfaces to replace corroded pipe. Were it not for a certain liability to internal corrosion where water vapour and hydrogen sulphide are present in appreciable quantities, there is no doubt that copper mains and services would be much more widely adopted for gas distribution in the United States.

The United States Government has also used copper pipes underground, and an interesting example is the installation in corrosive soil of a 2in. diameter gas line between the Continental Oil Field and Ship Rock, New Mexico—a distance of 7 miles.

Water Pipes in America.—For water distribution, copper pipes were buried underground in the United States even before their adoption by the gas companies. In the case of at least one company the decision to experiment with copper pipes for gas was the direct result of their successful employment for water. In 1926–27, after a thorough consideration of the serviceability of copper tubing for water connections it was decided to make it standard for all cases where ¾in. or 1in. pipe could be used in the Washington Suburban Sanitary District.[4] At that time this district had 250 miles of water mains and 11,000 services. Construction was in rapid progress and services were increasing at the rate of 1200 to 2000 annually. Soil conditions vary widely in the district. In many parts rock of varying degrees of hardness is encountered; in others there is a stiff clay or mixture of clay, loam, and sand. Elsewhere, sand, gravel, and river silt occur. During the ten years between 1918 and 1928 many old steel connections had been replaced. These varied in age from 8 to 25 years, and with few exceptions contained much clogging material. In many the waterways were so small as to be scarcely discernable. Outside surfaces, too, had frequently shown such pitting that it was impossible to thread the ends of consumers services left in the ground. The undertaking reports † that up to July, 1939, they had had no failures or maintenance trouble with any copper pipes used underground. In 1936, 1937, and 1938 they installed 1580, 1919, and 1775 services respectively. During the first six months of 1939 the number of copper services installed was 50 per cent. greater than the number in the same period of 1938.

Another company to standardise the use of copper pipes for services is the West Palm Beach (Florida) Water Co. In 1926 serious red-water trouble and low pressure complaints developed. As a result the company adopted cement-lined galvanised pipe, but in 1928 experiments with copper tubing were so successful that during the following year nothing but copper was used.[6] The water is soft and very corrosive.

The village of Keewatin in Minnesota has a population of 2200 and had a water supply using galvanised iron services. In 1925 on an average about 8s. 6d. per service was spent in repairing leaks in the distribution system. During 1936 all the services in the village—numbering 300—were replaced by copper.[25] The average length of service pipe was 40ft. and all services were installed at a depth of 7ft. or more to avoid frost troubles.

In 1935 nearly all the water companies operating in California used some copper tubing for water services, and in some cases, notably in the cities of Los Angeles, Oakland, San Diego, Santa Barbara, and Ventura, copper tubing is used extensively for that purpose.[14]

Australian Experience—Owing to the trouble and expense caused by the necessity for periodically renewing corroded galvanised wrought iron service pipes the Metropolitan Water, Sewerage and Drainage Board of Sydney decided, after exhaustive consideration, that from March 1st, 1926, all new or replaced water services from the mains to the meter or stop cock near the building line should be laid in solid drawn copper tube. With minor exceptions this was rigidly adhered to for six and a half years, when it was made permissible to use bituminous lined galvanised water piping at the

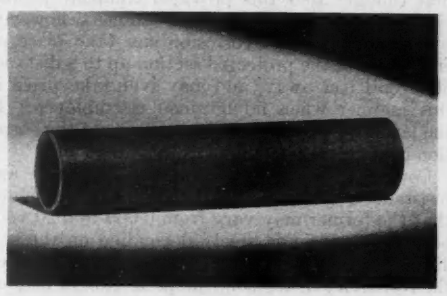


FIG. 6—EXCAVATED ¾ IN. GAS PIPE

owner's request where the street had not an expensive paving, subject to the condition that the Water Board could insist on galvanised iron pipes being surrounded with concrete or other suitable material if in their opinion external corrosion was likely.

From March 1st, 1926, till July, 1938, 138,000 copper services representing 5,500,000ft. of copper tubing were installed in Sydney, and up till June, 1939, only nine services had become defective—two due to split piping, and seven due to stray current corrosion. The thickness of the piping used is shown in the following table :—

Nominal outside diameter	¾in.	1in.	1¼in.	1½in.	1¾in.	1¾in.
S.W.G.	16	14	13	12	12	12
Inches	0·064	0·080	0·092	0·104	0·104	0·104

The experience of the Water Board over the last 12 years is that copper is the best material for buried water service pipes so far as Sydney water is concerned, and the almost complete freedom from leaks indicates the effective resistance of copper to soil corrosion in addition to its resistance to internal corrosion by the water.

In Melbourne and its suburbs approximately 16,000 copper services have been laid, and since 1937 nine defective services only have been reported. These services were in the ground between one and two years, and the cause of corrosion has not yet been established. In some cases the pipes were in ashes, which are known to have a deleterious effect on copper; in others the failure occurred under street channels. Owing to the number of failures experienced with other materials only copper or galvanised wrought iron with copper alloy bends at ferrules are permitted for water services of 2in. diameter or less. Copper alloy bends are used, owing to their freedom from incrustation and the longer life experienced than with ferrous bends.

No evidence is available with respect to other towns in Australia, though sufficient data has been given above to show that the resistance of copper to soil corrosion is fully appreciated in the two largest towns in that country.

British Experience.—A lead was given to the gas industry in Great Britain by the paper of J. Barker [16 17] in 1936 in which he described how, following experiments in March, 1927, the Nairn Gas Light Company had adopted copper for all gas services. ¾in. to 2in. diameter light gauge copper tubing which complies with B.S.S. 659 is used. Fig. 6 shows a length of copper tube removed after nine years underground in this area, and information from the company indicates that in twelve years they have had no internal or external corrosion trouble. They report that various services have been opened at intervals and test pieces cut out which have been found to be as good as when they were laid. The soil in the area is mostly of a sandy nature, though in a few places there is red clay. The thickness of the tubing used by this company is as follows :—

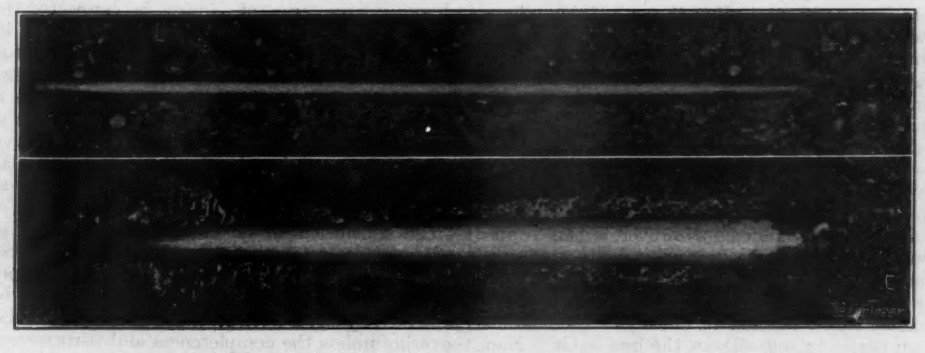
Nominal internal diameter	¾in.	1in.	1¼in.	1½in.	2in.
S.W.G.	19	18	17	17	16
Inches	0·040	0·048	0·056	0·056	0·064

Copper for water pipes underground has been used in many areas in this country, and an outstanding example in this respect is Dundee. Here the first copper pipes were used underground in about 1919, and, following the introduction of light gauge tubes and compression fittings, the use has extended to such a degree that it is unusual now for any other material than copper to be used for service pipes between the stopcock and the house. The pipes have given excellent service, and as far as is known no case of normal soil corrosion has been reported. The soil around Dundee is in some parts clay, and in others sand, though in the surrounding country different soils, including peat and marshland, are found.

An inspection of three copper pipe lines which have been installed underground in the Dundee area for 8, 15, and 18 years respectively has revealed that as yet the pipes show no signs of pitting. The ¾in. copper pipes are under a water pressure of 170 lb. per square inch, and the 2in. pipe has, for the greater part of its life, been connected to a hydraulic ram. A summary of the data relating to the pipes is given in the table above, and photographs of two of the pipes are shown in Figs. 7 and 8.

Situation of pipe.	Size of pipe.	Number of years since installation.	Number of places uncovered.	Condition of pipes.	Remarks.
Belmont, Meigle ...	¾ in.	8	3	Practically in the same condition as when installed	Reddish, loamy sand. Fairly dry.
Belmont, Meigle ...	¾ in. × 800 yd.	15	1	Slight green coating readily cleaned off. No pitting or corrosion marks.	
Lintrathen	2 in. × 500 yd.	18	2	Green at one site—coating readily removed; at other site pipe was black and could not easily be cleaned. In neither case were there pitting or corrosion marks.	Black, sandy loam.

(Inspection arranged and above data published by permission of the Water Engineer and the City Engineer of Dundee.)



FIGS. 7 AND 8—COPPER PIPES BURIED FOR 15 AND 18 YEARS IN SCOTLAND

† Private communication.

Manchester is another town using an appreciable amount of copper underground. There the water department uses 1in. by 18 S.W.G. copper pipes as subsidiary mains feeding short streets or cul-de-sacs. This practice has been employed for about 13 or 14 years, and during that time 60 to 70 miles of copper tube have been used. There has been no trouble whatever with soil corrosion.

There are other towns in addition to those mentioned where successful use is made of copper underground, and there are also numerous private users whose experience has proved entirely satisfactory.

Dissimilar Metal Corrosion

It is a well known fact that when two different metals are in contact in the presence of an electrolyte, a current flows between them which results in accelerated corrosion of the anodic or less noble metal and reduced corrosion of the cathodic or more noble metal. Thus, if a brass cock is screwed into a cast iron main, under suitable conditions a minute current tends to flow through the soil from the main towards the cock, and may cause increased corrosion of the iron main. In general, the area of the main is so large compared with that of the cock that the increase of corrosion is quite negligible. On the other hand, the protection afforded to the cock, which is relatively small, is appreciable. The same may occur when a copper service pipe is connected to an iron or steel main.

In America, when ferrous gas and water services are being replaced by copper, a common method of installing the new pipes is to open up the road at the main, cut the old pipe, and thread the new copper pipe through it. This is a very inexpensive form of repair, but one which has given rise to some criticism on the score of contact of dissimilar metals. For the reasons stated above, there is, however, little risk from this cause, since the steel acts as a protection for the copper and, at least until all the ferrous material is converted to oxide, the rate of corrosion of the copper is appreciably less than the rate which would occur if it were buried direct in soil.

In the early days of their use of copper pipes the Southern Counties Gas Company of California investigated this question of dissimilar metal corrosion [7] by inspecting junctions between copper services and steel mains, Tobin bronze collars on cast iron mains and on steel services, and bronze cocks connected to malleable iron fittings. These inspections disclosed the following :—

(*a*) Appreciable corrosion resulting from galvanic action occurs only in very corrosive soils.

(*b*) Where appreciable corrosion does occur, it is close to the connection between the two dissimilar metals. For example, when a copper service is connected to a steel main, any galvanic corrosion that occurs will usually take place within 3in. of the connection.

(*c*) Where the surface of ferrous metal exposed to soil action is small, as compared with the area of adjacent copper, rapid corrosion of the former does occur in bad soils.

To avoid difficulties which may result from galvanic action the company takes two simple precautions : (1) steel or cast iron fittings are not used with copper pipe underground, (2) at junctions of steel and copper pipe both are protected for a distance of two or three feet in each direction from the junction by applying a hot asphalt or coal-tar coating, reinforced with a fabric or asbestos felt wrapping.

In 1935 it was reported [14] that the company had found no new evidence bearing on the point which would tend to modify the conclusions given above. They had also investigated the suggestion that the presence of iron oxide produced by the corrosion of old steel pipes through which copper pipes were threaded would increase the rate of corrosion of the copper subsequent to the complete conversion of the ferrous material to oxide. Copper samples were buried in a mixture of 75 per cent. corrosive soil and 25 per cent. iron oxide and exposed to accelerated corrosion conditions as described in the first part of this article. The average loss of weight was three times as great as when copper samples were buried in the same soil to which no iron oxide was added. However, when copper samples were connected electrically to steel samples and both were buried in a 75 per cent. : 25 per cent. mixture, the loss in weight of copper was, in some cases, but not in all, about the same as when buried in soil without the iron oxide. None of the copper samples used in these tests lost more than a very small fraction of the weight lost by steel samples exposed to the mixture of soil and iron oxide. Average results for four specimens in each case were as follows :—

Material.	Soil condition.	Relative loss of weight.
Copper	Soil only	1·2
Steel	,, ,,	5·8
Copper in contact with steel	Soil and rust	1·0
Copper	,, ,, ,,	3·9
Steel	,, ,, ,,	218

Junctions between dissimilar metals are frequently painted with bitumen, and it was at first thought that this provided complete protection. It has recently been shown, however, by de Jonge [22] that corrosion can take place on either side of the protected section up to a distance of several feet away, and may even take place in this manner when no bitumen is employed. In the latter case, however, the majority of the corrosion is usually adjacent to the junction.

Corrosion currents depend on both voltage and resistance. Hough and Allyne [27] have found that the former may vary from 0·005 to 0·20 volts between copper and steel—depending on the soil. The resistance is dependent on the area of contact, the resistivity of the soil, the perfection of contact between pipe and soil, and the distance apart of the exposed areas. This distance is of less importance than is generally supposed, since the resistance of the exposed area is principally confined to the soil in its immediate vicinity. Thus, there is little difference in the resistance *via* the soil between, say, two areas of 1 square inch each situated 3ft. apart, and two similar areas situated 1ft. apart. This explains why appreciable corrosion can take place at some distance from a junction, and why the use of bitumen only reduces and does not eliminate dissimilar metal corrosion.

There are four possible conditions in which copper may be connected to ferrous materials in a distribution system.

(1) Copper to bare steel or cast iron.
(2) Copper to partially coated steel or cast iron.
(3) Copper to completely coated steel or cast iron.
(4) Copper to a well-coated steel or cast iron line, except for a few breaks or pinholes in the coating.

In all cases it would be the ferrous material which would be attacked, but Hough and Allyne concluded from their tests that in case (1) the corrosion would be negligible owing to the large area of ferrous material exposed, and that the result in case (2) would usually be similar. In case (3) no corrosion would take place. Case (4) is an important one and tests showed that corrosion of the steel or cast iron under these conditions could become serious. 150ft. of 2in. pipe was used as the copper electrode, and two 20ft. steel pipes were buried to provide the second electrode and a control specimen. On each of the steel pipes, at distances of 4ft., 10ft., 16ft., and 22ft. from the copper pipe, holes measuring $\frac{1}{2}$in., $\frac{1}{4}$in., and 1in. diameter were cut in the insulated wrapping of tarred felt. One steel pipe was connected to the copper pipe, and on closing the circuit a current of 8 milliamps was found to flow. The steel pipe was inspected at three-monthly intervals, and after nine months a number of bare spots were found to be perforated. The test was then concluded, the specimens dug up, the wrapping removed and the surfaces cleaned. There was no noticeable corrosion on the control pipe not connected to the copper. The size of the unprotected areas and their distance from the copper pipe apparently had no noticeable effect on the degree of corrosion.

From these tests it appears to be definite that where a large area of copper is connected to steel or cast iron pipes having imperfections in their covering, accelerated corrosion will occur in the vicinity of these imperfections. It will also occur on small steel or iron fittings used with a copper pipe system, and such cases of dissimilar metal corrosion are the only ones which have been experienced by the Southern Counties Gas Company of California, on whose behalf the tests were conducted.

The conclusion to be drawn from the above-mentioned tests is that when cast iron or steel pipes are to be connected directly to copper pipes underground the former should preferably not be protected by an insulating wrapping or other similar covering unless the completeness and permanency of the wrapping can be ensured, or unless the thickness of the pipes is such that a low rate of corrosion can be tolerated. The only exception to this rule would be that the pipes might be protected for a few feet on each side of the bimetallic connections with bitumen or some other suitable insulating material which would probably tend to reduce the danger of serious corrosion at this point.

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[2] K. H. Logan, S. P. Ewing, and C. D. Yeomans, "Bureau of Standards Soil Corrosion Studies : I. Soils, Materials, and Results of Early Observations." Tech. Paper B. of S. Journal of Research, Vol. 22, page 447, 1928, T. 368.

[3] K. H. Logan and S. P. Ewing, "Some Experimental Studies of External Corrosion of Copper and Brass Service Pipe." J. Am. Waterworks Assoc., 20, 1928, page 390.

[4] R. B. Morse, "Service Pipe Practice in Washington Suburban Districts." Waterworks Engineering, Vol. 81, No. 13, page 943, June 20th, 1928.

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[14] F. A. Hough, "Copper Pipe for Gas Distribution." Am. Gas Journal, January, 1936, 144 (1), page 31 ; February, 1936, 144 (2), page 17.

[15] T. W. Hughes, "The Corrosion of Underground Gas Mains and Services." Gas Journal, February 5th, 1936.

[16] J. Barker, "The Use of Copper Pipe between Mains and Consumers' Premises." Gas Journal, September 16th, 1936.

[17] J. Barker, "Copper Pipe for Gas Services." The Gas Times, September 26th, 1936.

[18] K. H. Logan, "Soil Corrosion Studies, 1934. Rates of Loss of Weight and Penetration of Non-Ferrous Materials." B. of S. Journal of Research, Vol. 17, November, 1936.

[19] U. R. Evans, "Metallic Corrosion, Passivity, and Protection." Arnold, London, 1937.

[20] K. H. Logan, S. P. Ewing, and I. A. Denison, "Soil Corrosion Testing." Symposium on Corrosion Testing Procedures." A.S.T.M. publication, 1937, pages 95–128.

[21] Scott Ewing, Proc. Am. Gas Assoc., 1937, pages 789–796.

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[26] Scott Ewing, "Soil Corrosion and Pipe Line Protection." Am. Gas Assoc., 1938.

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Hydro-Electric Progress in Canada

A survey of hydro-electric progress in Canada during 1939 shows that considerable activity took place not only in the installation of new generating capacity but also in the extension of transmission and distribution facilities. New water-power installations aggregated 97,040 H.P., which with an installation of 1400 H.P. omitted from the 1938 review brings the total for the Dominion at the end of 1939 to 8,289,212 H.P. The greater part of the increase was made up of extensions to existing stations in Saskatchewan, Ontario, and Quebec. New developments included a 3300 H.P. plant of Consolidated Mining and Smelting Company, Ltd., at Wellington Lake in Northern Saskatchewan ; a 2000 H.P. plant of Bevins River Mines, Ltd., on Duck River, in North-western Ontario ; a 7500 H.P. unit of the Ontario Hydro-Electric Power Commission in the Ear Falls station on English River. The Beauharnois Light, Heat, and Power Company brought into operation the ninth unit of 53,000 H.P. in its plant at Beauharnois on the St. Lawrence River and resumed work on the installation of the 10th and 11th units of the same capacity. A great many smaller developments were completed during the year and many more are in course of construction.

Italian Railway Accident.—When the engine and several coaches of the Rome–Pisa express train were derailed and overturned near Pisa on Monday, February 12th, five people were killed and twenty-four injured.

The Development of Irrigation*

By E. BRUCE BALL

IN selecting the title for my address, my object is to illustrate the ingenuity of mechanical engineers and the importance of their influence on the development of the human race. Mechanical engineers may be defined as *those whose mental powers are trained to solve, by mechanical means, problems of which the conditions and the results to be achieved are given.*

The mechanical mind was strongly developed from the dawn of civilisation when the early tribes and their flocks increased in numbers to an extent which made imperative migration from their original pastures where natural water was readily available. Tracts of land were available which would become highly fertile if watered, but which lacked the accustomed natural supply, and on these the new inhabitants had to devise means to raise water from rivers or shallow wells. This was at first achieved by the use of pots or other carrying vessels.

Probably the "Basket Scoop" was the earliest method devised to meet this increasing need for water and to save time and labour in raising it, and thus it marked the dawn of the mechanical mind, which evolved an apparatus to accomplish this end. This method became, and still is, extensively used throughout the East. Its use is limited to a lift of about 3ft.

Very soon the need was felt for improved methods of utilising to better advantage the labour available, and in the early history of man a great variety of mechanical devices was developed. These were constructed in the only available material, namely growing timber. Many of these have survived, with little or no change through the ages, to the present time.

One form embodies the principle of the pendulum, and is known as the "Scoop" or "Mantie." Another, employing the principle of the balance, is the "Doon," still to be seen in Bengal for lifts of about 2ft. to 3ft., and is usually made from half the stem of a palm tree hollowed out. The weight of a man is used to depress one end of a long scoop made from a split tree trunk into the water and a counterweight to raise it sufficiently to discharge into the irrigation canal.

Probably the most universally used device is the Egyptian "Shadouf," working on the same principle as the "Doon," but designed for higher lifts of 4ft. to 10ft. This is a crude but simple and efficient mechanical contrivance, and has survived from ancient times. The counterpoise is of clay bound to the oscillating beam, and clay piers support the cross beam.

A new problem arose with the need to draw water from greater depths and this was solved by the evolution of the pulley, a truly epoch-making event. It also made possible the employment of animal power in place of man, by converting the vertical lift into a horizontal pull, a momentous step in mechanical evolution.

The device known as the "Mote" has come down the ages with little change except some mechanical refinement in the way of a leather tubular extension of the vessel, to the lower end of which a form of valve is fixed. The valve is operated by a cord when the bag is at the top of its lift, allowing water to escape into the irrigation channel.

The principle of assisting tractive effort by gravity was known and adopted in those far-off days, and examples shown in Figs. 1 and 2, show a sloping path, down which the animals walked when receding from the well, thus applying their own weight in raising the water. The development of the mechanical mind is again in evidence in the application of a very sound device for maintaining the outlet of the discharge trunk above the water level in the vessel during its upward travel, and automatically discharging the contents when fully raised by means of the lower rope, attached to and travelling with the hoisting rope.

When the demand arose for improved appliances to raise greater volumes of water, and at the same time to employ the available labour for the cultivation of larger areas, the ancient mechanicians evolved the constant-delivery rotating machine in various forms, and at first used animals exclusively as the motive power. Much ingenuity was exercised in their construction, and of these machines the Persian Wheel, Fig. 3, is the most common and universally used. Fig. 4 shows a heavier and more advanced construction of the gearwheels.

FIG. 1—SLOPING PATH TO ASSIST TRACTIVE EFFORT BY GRAVITY

FIG. 2—AUTOMATICALLY DISCHARGING CONTENTS BY MEANS OF LOWER ROPE

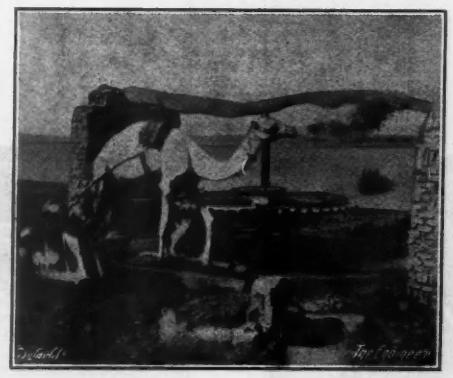


FIG. 3—PERSIAN WHEEL

It may be noted that in the Sudan, in the province of Dongola alone, there were at work 3892 of these machines in 1904, each irrigating on the average 15 acres of land and supporting 33 persons.

The lantern design of wheel staked on to the shaft should be particularly noted, as this type of gearing was extensively adopted in the water-wheel driven mills in this country. Often during the height of the irrigation season these wheels are worked continuously, and in the stillness of the night, both in Upper Egypt and in the Sudan, I have heard the very peculiar and insistent chorus of creaking and groaning arising from their unlubricated wooden shafts and bearings.

Another type, the "Noria," Fig. 5, shows a higher stage of mechanical design as compared with the "Sakia" or Persian Wheel, but it is inferior in hydraulic efficiency, owing to the increased height to which the water has to be raised for a given level, as well as to its limited lift. The "Noria" presumably ante-dates Egypt's Fifth Dynasty, 2560 B.C., when she reached the zenith of her civilisation, and her art, in particular, attained a perfection never again approached.

The mechanical mind next applied itself to use the energy in flowing water to replace animal power. Many examples have survived, and are still to be seen in Iraq on the Tigris and the Euphrates, with the pots suspended between two rim members of the wheel. The paddles themselves are generally formed of matting.

The fertile mechanical ingenuity of the Chinese produced the link chain pump, according to some authorities, over 3000 years ago, and these have continued in use with little change to the present day. Their problem was to transfer large volumes of water from canals or from field to field under relatively low heads and over sloping banks.

The Persian Wheel or Chain of Pots was undoubtedly known to them, but the difficulty attending their use in an inclined position, and the need to protect the pots when descending rough banks, would lead to the idea of substituting an open trough with pieces of wood fitting the full width and pushing the water before them with the motion of a wooden link chain, thus forming an endless conveyer.

During my travels in China, extending to nearly five years, I saw numbers of tread mill machines at work, and was much impressed by their effective design and construction; practically all were made entirely of wood and all members were connected by mortised joints or pegs. The wooden chain and pins also afforded an example of interchangeable manufacture, as practised from very early times.

These machines are exceedingly numerous, nearly every peasant possessing one. When a breach occurs in the canal or flood-protecting banks, hundreds of cultivators are called with their machines after the repairs have been made, and by their means the water is drained from large flooded areas in a short time.

During many centuries the design and construction of mechanical apparatus remained practically stationary, due to the rarity and costliness of materials other than wood, and to the difficulty of working them. With the development of the science of metallurgy the mechanical engineer was provided with the means which made possible the extraordinary scope and magnitude of present-day irrigation works.

This stagnation of mechanical development was not by any means due to want of incentive, for the need of effective control apparatus must have been very acute even in the early days, when the cultivation of large tracts of land commanded by the head waters of rivers was beginning to be undertaken. The method then available was the construction of temporary dams or weirs of timber or brushwood and earth, to divert the water into upstream take-off canals for distribution over the land. Each year these obstructions had to be removed, or were carried away by the flood waters, and they were reconstructed for the following irrigation season.

Solid permanent dams were not permissible, because of the obstruction they offered to the

* Institution of Mechanical Engineers, February 16th. From a presidential address entitled "The Influence of the Mechanical Mind on the Development of Irrigation through the Ages."

passing of floods with their burden of trees, silt, and sand. If arrested, they would rapidly accumulate, raising the bed of the river upstream of the dam and causing loss of control in training the river, with permanent and disastrous results. For such conditions, the impounding dam must be readily removable during flood periods, and be available for replacement as soon as the floods have passed. The construction of such a dam involved problems which could only be solved by mechanical means, with the aid of materials which were not available to the ancients. An example of a dam of this type is shown in Fig. 6. It consists of a series of automatic collapsing shutters, pivoted on the crest of a low weir, near bed level.

The tripping of these shutters in times of flood is started by the release of the shutter nearest one abutment. By an ingenious mechanical construction the support of each neighbouring shutter is tripped in succession, until the whole series falls like a pack of cards, flat on the river bed. This practically restores the river bed to its original condition, and allows all floating debris and accumulated silt to be swept over the shutters without hindrance.

In the first installations the shutters were reset by manual labour, sometimes assisted by a travelling block suspended from an overhead ropeway, but more recently a travelling resetting machine, Fig. 7, has been employed, with a winch-operated fishing tackle to raise and lock each shutter in its vertical position.

The successful construction of masonry impounding dams on large rivers commenced about 1843, and was made possible by the aid of the mechanical engineer in designing and constructing submerged iron sluice gates mounted on rollers with fixed axles, usually regulated by means of travelling gantries with powerful winch gear.

The limitations of water load and impounded head for this type of sluice necessitates the dam being constructed with a great number of narrow openings, and a corresponding number of piers, which cause an appreciable afflux when flood water is being passed.

The high cost and unsuitability of this type of structure for great rivers with sandy beds prevented vast areas of suitable land from being brought under cultivation, and it was not until 1870 that the mechanical mind made possible the construction of barrages with wide and deep gates through the application of the anti-friction "free-roller" principle to replace the fixed axle type. By means of this device gates 60ft. in width and from 12ft. to 25ft. in depth have become the present-day standard, and examples are to be seen in the Punjab and elsewhere. For special conditions many gates have been made greatly exceeding these dimensions.

These barrage gates are all completely counterbalanced, and are provided with independent operating gear. So efficient are they that they can be easily raised by the effort of two men with water loads of 500 tons on the gates.

A typical example of a modern sluice gate barrage is the Panjnad barrage in the Punjab. This comprises forty-seven free-roller sluice gates, each of 60ft. span, and is the last of four barrages on the Sutlej River. It is situated immediately below the junction of the tributary rivers, Jhelum, Chenab, Ravi, and Beas. The canals taken off from these rivers irrigate 11,000,000 acres of what was previously barren land.

There is a similar barrage on the Sarda River in the United Provinces, near the foot-hills of the Himalayas, situated in the heavy shingle zone. Several of these thirty-four 50ft. span gates are fitted with automatic lifting gear to release sudden floods, and the remainder are operated by hand. Fig. 8 shows the general construction. The Sarda Canals and branches supplied by these head works extend to 6000 miles. The cost of their construction was £7,000,000 and the work occupied eight years for completion; the area irrigated is 1½ million acres.

Electrical operation of sluice gates is adopted where large sizes and numbers are involved. Where each gate is fitted with its own independent motor the operating crew is reduced to one or two men. In cases where two or three portable motor or small oil engine units mounted on trolleys are adopted, a crew of three men for each is usual.

Fig. 9 shows the arrangement of the independent motor operated type. The gates are 60ft. span×20ft. deep; each weighs 52 tons, and the water load on the gates is 385 tons.

To reduce the height of the overhead superstructure, the counterweight is frequently suspended in the bight of the wire rope. By this means the counterweight travel is half the gate lift, and in consequence is double the weight, to preserve balance.

Where suitable foundations are to be found, masonry dams can now be built far greater in height than their original prototypes, due solely to the mechanical application of free rollers to sluice gates. The introduction of this design immediately opened the way to the creation of vast reservoirs of great depth, by making possible the use of regulating sluices under high heads.

It should be realised that the creation of the Aswan dam as it is to-day, impounding the waters of the Nile to a depth of 120ft. and extending upstream to a distance of 200 miles, was only possible through the ingenuity of the mechanical engineer, whose control machinery enables the full flood flow to pass through the sluice culverts formed in the heart of the dam.

The problem of isolating submerged sluice culverts, for examination and maintenance of the sluice gates and under-water parts without emptying the reservoir, was also solved by the mechanical engineer by an extension of the free roller principle to the design of a shutter gate or curtain shown diagrammatically in Fig. 10.

This gate is lowered down the face of the dam, and is capable of closing any of the culvert openings under full impounded head, with full sluice opening and free discharge. It consists of a number of main rollers spanning the culvert opening, held between side frames and rotating on axles. The spaces between the main rollers are occupied by smaller staunching rollers, which are kept in position by the hydraulic pressure, and are rotated in the opposite direction by the main rollers. The whole assembly forms a completely free-rolling unit, and cuts through the high-velocity stream of water by virtue of its weight, which is much greater than the frictional resistance to movement arising from practically pure rolling alone.

Fig. 11 shows an example of this type of emergency closing gate for closing culverts under 150ft. head (evidently made the occasion of a staff photograph).

Irrigation plays an important part in the life of a nation by giving employment to its people and eliminating recurrent famines which formerly decimated the population. This is shown by the fact

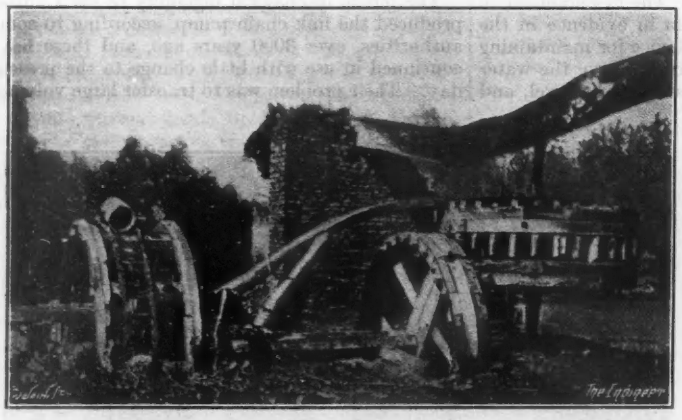


FIG. 4—HEAVIER AND MORE ADVANCED PERSIAN WHEEL

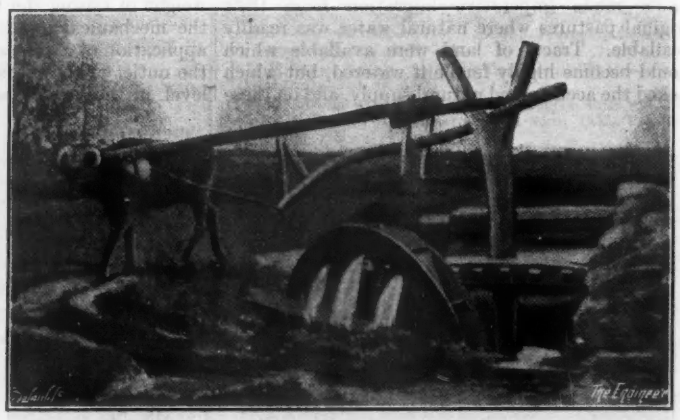


FIG. 5—THE "NORIA"

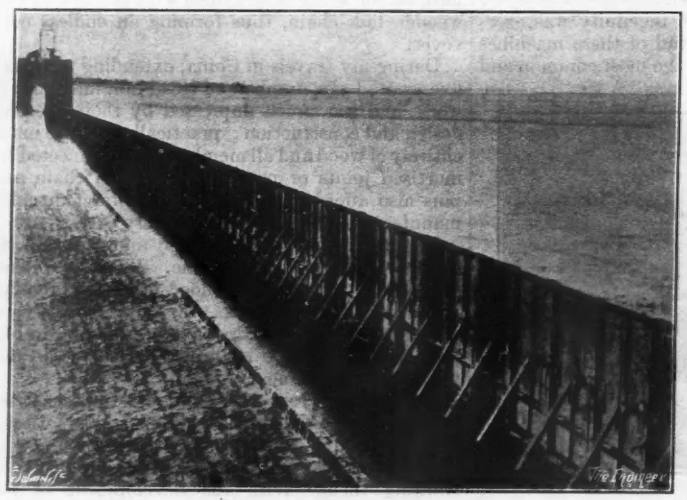


FIG. 6—DAM CONSISTING OF A SERIES OF AUTOMATIC COLLAPSING SHUTTERS

FIG. 7—TRAVELLING RESETTING MACHINE

that in India alone the area irrigated represents 59,000,000 acres in average years or approximately one-fifth of the total cultivable area. About 50 per cent. is irrigated from canals, 25 per cent. from wells, and 25 per cent. from lakes, small streams, and other sources. The capital invested in Government canals is £115,000,000, which yields a net return of 5¼ per cent.

It may also be mentioned that in Madras Province 7,000,000 acres are irrigated by the waters of the Cauvery-Kistna and Godavari Rivers, whilst the Sukkur system in Sind now irrigates 5,300,000 acres of desert land with a total length of major canals and minor branches of 5500 miles; this was constructed at a cost of £15,000,000.

Part of the potential water power available in these irrigation works has in recent years been developed, and to this the mechanical engineer has contributed his full share. Although much has already been done, there are vast resources still awaiting development.

These few examples, from only one branch of our profession, illustrate the important part played by the mechanical engineer in assisting nature to maintain the population of the world, and to raise universally its standard of living.

What I have said may be regarded as one illustration of the dependence of human life on the creative work of the mechanical engineer. This dependence applies equally to the vital part played by science and industry, as represented by all engineering institutions, in our present-day civilisation and mode of life. The work of the mechanical engineer embraces transport by land, sea, and air, the production of food and clothing, all essential services such as the distribution of purified water, hygienic sanitation, the harnessing of electricity to our needs, and the provision of the amenities within our homes, as well as the highly mechanised equipment of our navy, army, and air force, on which depends the safety of our country and Empire.

The importance of the work of the engineer entitles him to wider recognition and the opportunity to contribute a greater share in the councils of public affairs.

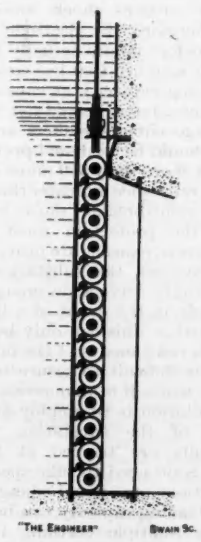


FIG. 10—DIAGRAM OF ROLLER EMERGENCY GATE

In his status of citizen he has had the opportunity of higher education and is in a position to give critical thought and support to measures initiated for the public good. As a result of his education and experience, he is trained in the technique of honest thinking. He analyses current problems by reducing them to their simplest terms and discriminates between reliable and faulty data. He is trained to distinguish between the possible, the probable, and the actual. A basic contribution of the engineer to society is his respect for the truth and his training in reasoning correctly and cautiously from given premises.

The engineer in speaking to the public tends to argue for the "best plan," to tell the "whole truth" as he sees it, partly because of his education, partly from habit, and partly because of his reputation for being logical, consistent, and impartial.

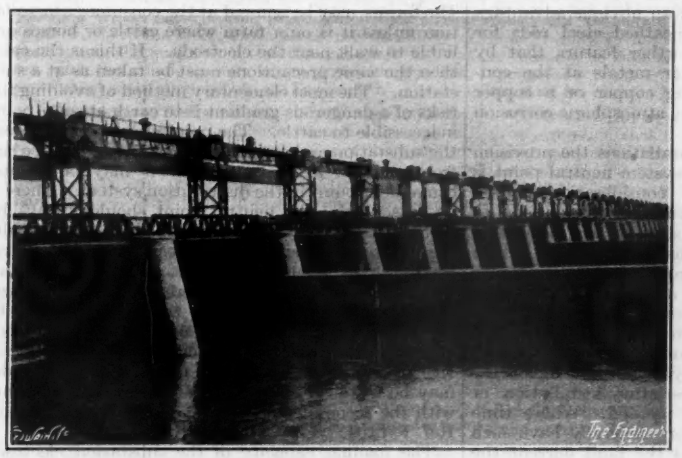


FIG. 8—BARRAGE ON THE SARDA RIVER IN THE UNITED PROVINCE

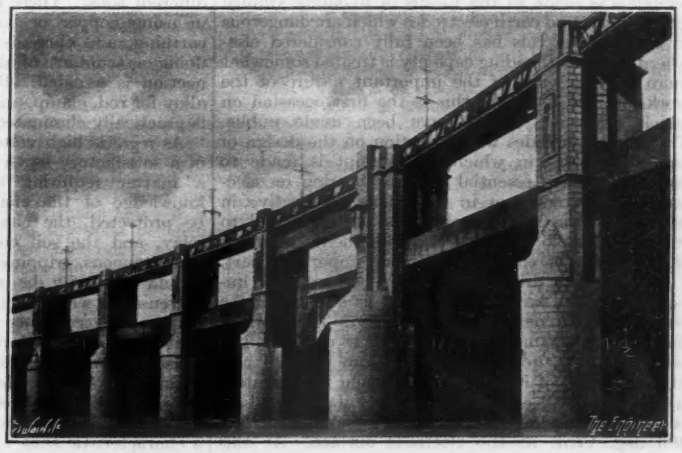


FIG. 9—ARRANGEMENT OF INDEPENDENT MOTOR-OPERATED SLUICE GATES

It is encouraging to find that his experience is now being utilised to an increasing extent in an advisory capacity by the Government of to-day. The present emergency has afforded this opportunity and it is to be hoped that it may become a permanent feature in the administration of the country.

FIG. 11—EMERGENCY GATE FOR CLOSING CULVERTS

American Engineering News

Aluminium Alloys in Structural Work

Heat-treated aluminium alloys, first developed in the United States for aircraft construction, are now used for a variety of structural work. Of two of these strong alloys, A and B, the first is notable for high strength and the light weight common to such alloys; the second is highly resistant to corrosion. The proportion of alloying elements is relatively small. Thus, alloy A contains nearly 94 per cent. of aluminium, with 4·5 per cent. copper, 0·8 silicon, and 0·8 manganese. In alloy B, aluminium is nearly 97 per cent., with 0·7 silicon, 1·3 manganese, and 0·25 chromium. With this latter alloy exposed to industrial or sea-coast atmospheres only superficial attack of exposed surfaces is to be expected, as the surface layer of oxide protects the underlying metal and the rate of attack gradually diminishes so that corrosion tends to be self-stopping. On the other hand, it is not suited for exposure under water, since the initial corrosion produces a covering of gelatinous texture which affords no protection to the underlying metal. In structural work of this alloy, priming with an inhibiting paint is advisable. The alloy A is used extensively for shop fronts and window frames, showing little effect from industrial atmospheres. Where weight saving or appearance is important, hot or cold alloy rivets may be used, and a shear strength of 34,000 lb. can be obtained with hot-driven rivets. As a rule, however, hot steel rivets are used. Cold-driven steel rivets have been used, in holes $\frac{1}{32}$in. large, with a squeeze riveter giving a pressure of 52 tons for ¾in. rivets and 72 tons for ⅞in. rivets. These particular alloys have been used in movable dams, flood gates, shipbuilding, mine cages, and heavy-duty mining equipment. Their characteristics are as follows:—

	Alloy A.	Alloy B.
Tension; yield strength	50,000 lb.	33,000 lb.
Tension; ultimate strength ...	65,000 lb.	33,000 lb.
Shear; yield strength	30,000 lb.	20,000 lb.
Shear; ultimate strength	39,000 lb.	24,000 lb.
Endurance limit	13,000 lb.	11,000 lb.
Elongation per cent. on 2in. ...	11 p.c.	20 p.c.
Brinell hardness	115	80
Weight, per cubic foot...	174 lb.	168 lb.

Methane Gas for Engine Fuel

A RECENT report of the Illinois Water Survey Department reviews the development of anaerobic fermentation in recent years, particularly in the application of the methane gas thus produced to power and industrial purposes. The report supplements earlier reports of studies in sewage sludge digestion. Apart from sewage sludge it covers experimental work with fermentation of organic acids, cellulose, fibrous materials, sugar-beet wastes, milk wastes, packing-house wastes, cannery wastes, and beer and distillery wastes. Gas from distillery wastes is estimated to cost from 2 to 4½ pence per 1000 B.Th.U., as compared with 3 pence for soft coal or 7½ pence for natural gas. An experimental plant to determine whether anaerobic digestion plus some subsequent treatment could be used for complete treatment of distillery waste consisted of two digestion tanks and a trickling filter, the tanks having steam coils at the bottom and gas domes on the covers. As to gas production it appeared that farms could use small gas-producing units operating on cornstalks, straw, manure or other fermentable wastes, although it would be still more satisfactory to ferment ground grain, spoiled fruit, and other materials leaving little residue. As to municipal wastes, in the United States waste-treatment tanks were fitted with gas collectors by Mr. Hommon in 1915, and the gas was utilised. A general conclusion presented in the report is that anaerobic digestion as a method of waste disposal is quite economical, since the gas is produced as a by-product, and under good conditions the process can be made to pay for itself. But for general use under present economic conditions fuel gas produced by anaerobic fermentation is too expensive to compete with other kinds of fuel if the raw material must be purchased or must be transported any considerable distance.

TOOL AND DIE STEELS TREATMENT.—We have received from Thomas Firth and John Brown, Ltd., of Sheffield, a tool and die steels treatment chart, which is intended for the use of foremen and charge hands responsible for the treatment of such steels. A colour tempering chart for carbon steel tools is incorporated, and the complete chart should prove a valuable source of reference.

Practical Aspects of Earthing

A PAPER on "Practical Aspects of Earthing" was presented by Messrs. E. Fawssett, W. H. Grimmitt, G. F. Shotter, and H. G. Taylor at a meeting of the Institution of Electrical Engineers on Wednesday, February 14th. Earthing is first considered in relation to the various regulations applicable in Great Britain. These regulations relate to the generation, transmission and use of electricity, and the last item covers use in all types of consumers' premises. Particular attention is given to the peculiar difficulties attendant upon supply in rural areas, where protection is difficult to obtain. The factors affecting the resistance of earth electrodes are their size and shape, and the resistivity of the soil. All these items are dealt with in detail, including an analysis of the effect of rainfall on electrodes, both with and without artificial treatment. This analysis is based on the results of E.R.A. tests which have been in progress for 7 years. Only brief reference is made to the means of avoiding voltage gradients around earth electrodes which are dangerous to cattle, since this has been fully considered elsewhere. Current loading capacity is treated somewhat more fully in view of the important nature of the work and the fact that this is the first occasion on which any such results have been made public. The paper concludes with a section on the design of earth electrodes in which an attempt is made to correlate all the essential features bearing on electrodes, to show them in their true perspective in relation to the whole problem of earthing, and to relate the whole to practical requirements in which the question of cost plays a very important part.

The following are the conclusions of practical importance which have been reached as a result of the research on current-loading capacity. The work is incomplete, as it has been restricted to clay soil, but tests on an entirely different soil are planned and other features of importance are being investigated. (i) Failure of all electrodes in clay soil is caused by the attainment of a temperature of approximately 100 deg. Cent. at the electrode surface. At this temperature the moisture present evaporates and the resistivity of the soil increases to a very high value. (ii) The time-to-failure depends on the type of loading—whether long-duration loading, short-time or long-time overloading—and may be determined from a knowledge of the characteristics of the electrodes and the soil. (iii) In clay soil, with alternating current, small leakage currents flowing for a long time do not impair the characteristics of an electrode, since they reduce its resistance. (iv) Small direct currents seriously impair an electrode's characteristics if they flow for a sufficient length of time and if the electrode is connected to a positive lead. This means that in a direct current system a fault on a main which is positive with respect to earth tends to isolate itself by increase of the consumers' earth electrode resistance, whereas a fault or a general low insulation resistance on a main which is negative to earth is injurious to the substation electrode. This suggests that osmosis is not the only reason why earth faults are more often found on the negative than the positive conductor. The resistance at the positive electrode very quickly falls after the supply has been switched off, and a test with an alternating current may not reveal any abnormal increase. (v) The overload capacity of a salted electrode is higher than that of an unsalted one. (vi) The overload capacity of a coke-treated electrode is very much higher than that of an untreated one if the amount of coke used is sufficient considerably to increase the surface in contact with the soil. (vii) Heating of the soil around an electrode has the advantage that the moisture present absorbs an increased amount of salt from the soil, and on the fall of temperature this salt may remain in solution, and thus the electrode resistance may be permanently reduced. (viii) The overload capacity of an electrode is roughly the same with direct current as with alternating current. (ix) Until the temperature at the surface of an electrode approximates to 100 deg. Cent., the voltage gradient on the surface of the ground does not alter sufficiently to affect appreciably the shock risk to animals. (x) The life of an electrode exposed to short-time overload is inversely proportional to the specific loading, which is given by i^2p, where i is the current density on the electrode surface and p the resistivity of the soil.

To be satisfactory, an earth electrode must comply with the following requirements:—(i) It must have a sufficiently low resistance, at any time of the year, to pass enough current to operate the protective gear under fault conditions. (ii) It must carry the fault current for a sufficient time to operate the protective gear without excessive increase of resistance, *i.e.*, it must have adequate current-carrying capacity. (iii) The voltage gradient on the surface of the ground around the electrode must not be dangerously steep. (iv) The electrode and its connection must have a high resistance to soil and atmospheric corrosion. (v) For certain cases the electrode must have a sufficiently low surge impedance to prevent a flashover from earthed metalwork to insulated conductors when a lightning discharge takes place.

(vii) How much is it possible to spend on earthing and other protective means as an insurance against accidents through electric shock? In this connection it should be remembered that the total cost is a function of the number of consumers plus a fixed charge, and consequently the smaller the area supplied the larger the cost per consumer and the smaller the profit on the scheme for a given degree of protection. (viii) In all earth-electrode installations particular care should be taken to ensure that the electrode is installed and connected up in a permanent and efficient manner, since once it is installed it is the most likely part of the whole system to be completely ignored for years. The I.E.E. Regulations for the Electrical Equipment of Buildings state that "Every connection of an earthing lead to a pipe, conduit, cable-sheath, armouring, or earth electrode, shall consist of a substantial clamp, constructed of a non-rusting material such as copper, and the contact surfaces shall be clean." According to soil-corrosion studies of the Bureau of Standards extended over a period of eight to twelve years, the average rate of corrosion of wrought iron and mild steel in soil is 15 times that of copper. This result was obtained by taking the mean of the results for 31 different soils. There is thus an obvious advantage in using copper or copper-sheathed steel rods for earthing, and there is the further feature that by doing so contact of dissimilar metals at the connection is avoided. By using copper or a copper alloy for rod, clamp, and cable, atmospheric corrosion is practically eliminated.

As regards high voltage installations the provision of a satisfactory earth for a system neutral point is a matter requiring careful consideration and a knowledge of the characteristics of the circuit to be protected, the characteristics of the protective relay, and the soil conditions at the site. Where instantaneous tripping is provided, low resistance should primarily be aimed at, and this indicates driven rods, which should not be installed at the substation in accordance with a set plan, but rather concentrated in that part found to have the lowest resistivity, as determined by measurement of the resistance of trial electrodes after installation or by using the four electrode method. Where time delay relays are provided, they generally have such a characteristic that whatever the fault current the time required to operate is such that the temperature rise of the protected apparatus is a constant. This means that the time is inversely proportional to the square of the current. The temperature rise of an earth electrode follows the same law, and therefore in designing an electrode to meet certain conditions it is only necessary to ensure that the time for the relay to operate at any given current is less than the life of the electrode at the same current. The latter may be determined for London clay from the formula relating the life of the electrode to the specific loading. Investigation is now planned to determine the constant in this formula for other soils.

The design is not straightforward, since the fault current is dependent on the resistance of the earth electrode, which in turn depends on its size, and consequently any change in the resistance of the electrode affects the loading capacity in two ways—by change of fault current and by change of surface area of the electrode. It is therefore essential to know the impedance of the fault-current circuit, and it will be necessary to make some assumption about the maintenance or otherwise of the supply voltage during fault conditions. Where the current is of the order of thousands of amperes, a considerable surface area is required to dissipate the energy without failure of the electrode, and this can only be provided by a generous use of driven rods on the lines adopted in the U.S.A., or by the use of plates, strips, or conductors in parallel with rods.

There are ten main uses for earth electrodes on l.v. systems, of which the principal are those relating to neutral-point or consumer's apparatus earthing on alternating current systems using the normal method of earth-fault protection, protective multiple earthing, and earth-leakage circuit-breakers.

Whilst electricity supply was restricted to urban areas, or large villages possessing water mains, and a water supply in each house, the problem of providing adequate protection against earth faults by means of fuses did not present any serious difficulty. In recent years, however, supply has extended to rural areas where it is no longer economic to use cable (and thereby provide a metallic sheath for earthing) and where no water mains exist. Furthermore, the use of electric cookers and other large current-using appliances has considerably extended, with the result that very low earth-path resistances are required to enable the fuses to be blown. It is by no means uncommon for a 30-ampere fuse to be installed, and this may only be blown in less than a minute at the supply voltage if the earth-path resistance is no more than about 4 ohms. To ensure complete protection, it should be possible to blow the fuse at the maximum voltage with which a person may safely make contact. Some measure of alleviation is provided by the fact that the fault usually occurs on a sub-circuit, which is probably protected with a 15-ampere fuse, thus permitting 8 ohms in the earth circuit. From this value must be deducted the resistance of the fault, the resistance of the earth-continuity conductor in the house, and the resistance of the supply mains. The net result is about 5 ohms, and this must not be exceeded by the combined earth resistance at the consumer's premises and the substation.

The cheapest method of securing such resistances is generally by means of driven rods. If the soil resistivity is 1000 ohm-cm. (a value which occurs with many clays), a resistance of 0·5 ohm may be secured at the substation for a cost of about £3, and 3 ohms may be obtained at the consumer's premises for 8s. These costs are not unreasonable, but if the resistivity increases to 5000 ohm-cm. the cost increases to about £8 for 1 ohm at the substation (as compared with 26s. when $p = 1000$ ohm-cm.) and £2 10s. at the consumer's premises. The latter, at least, is a value which could not be contemplated for each individual house in a village, and if the resistivity is any higher it is quite impracticable to provide protection by ordinary earthing for any but lighting consumers. Where the resistivity is exceptionally high, consideration should be given to neutralisation—a form of protection in which complete reliance is placed on the neutral for clearing all earth faults.

If ordinary earthing is to be used, dangerous voltage gradients must be avoided around the electrodes and adequate current-carrying capacity must be provided. The former may be ignored at the consumer's installation unless it is on a farm where cattle or horses are liable to walk near the electrode. If this is the case, then the same precautions must be taken as at a substation. The most elementary method of avoiding the risks of a dangerous gradient is to earth at some point inaccessible to cattle. The point chosen may be near the substation and an insulated conductor may be run from the l.v. neutral point, or it may be at any convenient point in the distribution system. There is no reason why the neutral point should always be earthed at the substation; equally satisfactory results are ensured by making a connection to the neutral conductor at some other point. Not only can this be made the means for overcoming the voltage-gradient trouble, but also in this way use may be made of some existing low-resistance earth electrode such as a short length of water pipe. As an alternative to choosing a safe place for earthing, electrodes may be installed at the substation site in accordance with the recommendations set out in E.R.A. Report Ref. F/T104.

The loading capacity of the substation electrode is the next most important feature. Several resistance faults may occur on a distribution system, no one of which is of sufficient magnitude to blow any fuses, and these may flow almost indefinitely, since the majority of substations are unattended and measurements of earth currents are seldom taken. The criterion of danger is the displacement of the voltage of the neutral point with respect to earth; if this exceeds about 30 volts in low-resistivity London clay, the earth electrode will eventually fail through excessive temperature-rise. In almost any other soil the permissible value would be higher. This matter should also be borne in mind with respect to electrodes at consumer's premises; it is possible for quite appreciable fault currents to flow without the blowing of fuses, but in general there is some other indication such as shock, smell, or signs of burning. Furthermore, the electrode would be seen to be steaming before failure actually took place. It may therefore be assumed that less consideration need be given to loading cap acity at consumer's premises than at substations, butit should not be ignored.

If earth-leakage circuit-breakers are employed, a 6ft. driven rod should be used, and provided this has a resistance of not more than 500 ohms it will be satisfactory. If the resistance is greater than this, a special earth-leakage circuit-breaker must be used or the sensitivity of the protection must be sacrificed. Where such protective means are provided throughout a distribution system, the substation neutral-point earth should, strictly, have a low enough resistance to cut off the supply in the event of a live line making contact with earth. This can only be effected if the substation earth resistance is of the order of 1 ohm—a value which is difficult to secure in any but low-resistivity soil; where it is an uneconomic proposition the only safe solution is to employ an earth-leakage circuit-breaker of the substation type. Because consumer's faults are tripped at the consumer's premises there is no need to take special precautions at the substations to avoid dangerous voltage-gradients, and loading capacity can be ignored.

If protective multiple earthing is used, return power current may flow continuously through both consumer and substation earth electrodes. The actual value will be relatively small, since an essential feature of this form of protection is a low-resistance neutral conductor. The permissible values for earth electrode resistance at substations and on the distribution system are laid down elsewhere. The lower these resistances are, the safer is the system if a broken neutral wire occurs. Voltage gradient and loading capacity may largely be ignored. At consumer's premises 6ft. electrodes are recommended.

TRANSPORTABLE EMERGENCY PUMPING SETS FOR A.R.P. SERVICE.—In the article which appeared in our issue of February 9th, describing three transportable emergency pumping sets, we stated that the sets were designed to cope with a fire risk of the first magnitude, whereas they were supplied to provide an adequate emergency pumping installation to cover a first order risk. The type of engine employed is the 6B Fowler-Sanders engine, and not the 6D type as stated in the article.

Rail and Road

BLACK SEA–CASPIAN RAILWAY.—A note in the *Railway Gazette* says that, according to the Moscow radio, the Soviet Government has begun work upon the construction of a new 70 mile railway from Jubfa eastward to Minjevan along the U.S.S.R.—Iranian frontier. When finished, this line will complete an alternative railway from the Black Sea to the Caspian, running along the Turkish and Iranian frontiers.

ROAD ACCIDENTS.—A return of the Ministry of Transport shows that during January 619 persons died as a result of road accidents in this country. It shows a considerable reduction on the 1155 deaths which occurred in December last, but it must be borne in mind that the severe weather conditions prevailing in many parts of the country during the month caused a large reduction in the number of persons and vehicles using the roads.

THE CHANNEL TUNNEL.—Replying to a proposal that the construction of a Channel tunnel should again be considered, the Prime Minister stated that the Government saw no reason to modify the attitude adopted in 1930 in a White Paper. This paper stated that having regard to the element of doubt as to the feasibility of construction, the weakness of the economic case, the great cost, and the small amount of employment provided, construction of the tunnel could not be justified.

L.M.S. SENTINEL STEAM COACH.—The London, Midland, and Scottish Railway Company's Sentinel steam rail coach No. 29913, which has recently been withdrawn, was the only one of its type in use on the L.M.S. It was built in 1928 and taken over by the company in the following year, after trials in the Mansfield, Ambergate, and Chesterfield district, and later on the Northern Division. The car was a six-cylinder 100 H.P. geared unit with carden-shaft drive, having seating capacity for 44 passengers. It was officially allocated to the Northern division in June, 1930, and worked for a considerable time on the Elvanfoot and Wanlockhead Branch—the highest standard-gauge line on the system—until its closure at the end of 1938. Latterly the coach had been stationed at Hamilton.

COTTON IN ROAD CONSTRUCTION.—During the past two years twenty-four states in the United States have been co-operating with the Public Roads Administration in the use of cotton fabric for road construction and over 600 miles of such roads have been laid down. The common procedure at present followed in the construction of such a road is as follows:—After being graded and brought to the desired cross section the base is primed with bituminous material and allowed to stand for 24 hours. The cotton fabric is then laid on the surface and bituminous material applied to it. It is then covered with crushed mineral aggregate ranging from ¾in. to 1¼in., which is rolled level, and on top of this a layer of lighter chips and bituminous material is rolled in. Cotton cloth with a fairly open weave and having a breaking strength between 25 lb. and 45 lb. has been found most suitable for this class of work.

GERMAN RAILWAYS.—An article entitled "The Enemy's Strength" in the *Railway Gazette* deals with the reports which have recently appeared in the Press of this country on the German railway system. The article concludes with the following statement:—"The very considerable volume of evidence and information at our disposal leads us to the conclusion that the railway system in Germany proper has been maintained up to the outbreak of war in a high state of efficiency, and in general was adequately provided with motive power and rolling stock. The position may be considerably less strong in acquired territories, and such acquisitions as Austria, Poland, and, to a smaller extent, Sudetenland, may have weakened the average position statistically. At the same time, Germany is not fighting on all fronts, and it would seem that from the Allied strategic point of view the principal interest lies in the efficiency of the railways in Western Germany, and of the rail access thence from important industrial and military centres."

REPAIR OF MILITARY MOTOR VEHICLES.—Motor vehicles from the British Expeditionary Force needing repair are now coming back to this country, and are being sent under the scheme arranged by the Ministry of Supply in co-operation with motor trade organisations for repair in civilian garages. So far, most of these returned vehicles are those impressed as a temporary measure from civilian sources at the beginning of the war. They are being replaced in France by new, specially-built Ministry of Supply vehicles which are better suited for military purposes. It is, however, the intention of the Ministry that not only impressed vehicles but all vehicles which can be repaired in this way shall be sent to trade garages in this country as the war proceeds. So well has the British motor industry responded to present heavy demands that it has not been necessary for the Ministry to purchase any vehicles abroad for use in France since the outbreak of war, and it is confidently expected that all future requirements will be provided from works in this country.

THE RAILWAY STAFF NATIONAL TRIBUNAL.—The Minister of Labour has been requested by the railway companies and railway Trade Unions to appoint a new chairman to the Railway Staff National Tribunal, owing to the resignation fo Sir Arthur Salter. The Minister has appointed Sir John Forster to the post. Sir John is a barrister and is deputy umpire under the Unemployment Insurance Acts and a chairman of the Industrial Court. He has been appointed from time to time by the Minister of Labour and National Service to act as arbitrator and as chairman of Boards of Arbitration under the Industrial Courts Act, 1919. He was chairman of the Court of Inquiry appointed in 1937 in connection with the stoppage of the London Central Omnibus Services and afterwards acted as chairman of the conferences which took place during 1938–39 between the London Passenger Transport Board, the Transport and General Workers' Union, and the Medical Research Council on the health of London busmen. He was also a member of the Baillie Committee which was appointed in 1936 to enquire into the regulation of wages in the Road Transport Industry (Goods).

Miscellanea

ACCELERATING ARMAMENT PRODUCTION.—When the Minister of Labour met representatives of the Confederation of Shipbuilding and Engineering Unions on Tuesday, February 13th, he handed them proposals for an intensified effort in the engineering industry to speed up the production of armaments.

QUARTZ OSCILLATORS.—Some years ago, the Department of Scientific and Industrial Research issued a book summarising the available information on the construction, properties, and the scientific and industrial applications of quartz crystals. A new and up to date edition of the book, which has been largely re-written by the author, Dr. P. Vigoureux, has recently been published by H.M. Stationery Office.

SWEDISH IRONWORKS SCHEME.—A note in the *Iron and Coal Trades Review* says that the Swedish Ministry of Commerce is proposing the establishment of State blast furnaces near Lulea, in North Sweden, a purpose for which the Swedish Parliament will be asked to vote 13 million kroner. The annual output capacity will be about 90,000 tons, and the equipment will comprise blast furnaces equally suitable for making charcoal and coke pig-iron. A minority is said to be in favour of the erection of a sponge-iron plant on the ground that all raw materials required are close at hand.

TELEPHONE LINES AND STORM DAMAGE.—In replying to a suggestion that a majority of the telephone lines in this country should be placed underground, the Postmaster General said that he could not accept the suggestion that most of the lines in southern and western England were brought down whenever there was a snowstorm or gale. The recent snowstorms were exceptionally heavy in the south-western region, but even at the worst period the proportion of telephone subscribers' lines out of order in that region was less than 4 per cent. He pointed out that it was the policy of his Department to provide telephone service by underground wires in preference to overhead, wherever this would be reasonably economical; and over 14¼ million miles, or more than 90 per cent., of a'l Post Office telephone wires were already underground.

SILVER IN STAINLESS STEEL.—At an exhibition of the chemical industries in New York in December last, a silver stainless steel was displayed in the form of sheets and castings by the Chemical Foundation Inc. Some interesting notes of this new product are given in *Metals and Alloys*, which says it has been developed primarily to resist pit corrosion, but its other characteristics include free machining, low work hardening, increased heat conductivity, and ability to take a high polish. Its production involves a special technique, as if silver in the common form is attempted to be introduced into a corrosion resistant alloy under the usual melting temperatures employed it will largely volatise and be lost. In order to secure the full advantage of the new product it must be introduced in such a manner that the silver is finely divided and homogeneously dispersed. To do this silver is first combined with nickel in the form of a master alloy and this is used as the addition agent. If properly introduced the silver will be found in a stable form in the ultimate alloy which may be reheated and repoured without any substantial loss of silver.

EMERGENCY JOINTING OF CABLES.—At an informal meeting of the Institution of Electrical Engineers, Dr. P. Dunsheath, opened a discussion on "The Emergency Jointing of Cables." He described an equipment for dealing with the rupture of electricity supply by enemy action and showed a number of slides illustrating the inexpensive set of materials which has proved efficacious in the rapid restoration of supply. Dr. Dunsheath stressed the point that in developing the process first consideration had been given to the restoration of supply in the shortest time possible. The temporary nature of the work was obvious, but experimental repairs put into general service eight months ago were still in commission. The process is built round a new cold-mixed compound consisting of a black liquid blended on site with a grey powder. A limited number of inexpensive parts is required to cope with the repair. A shaped and perforated lead sleeve, split so as to clamp upon the conductor, is bound at each end by a lead wire starting from the conductor. A wooden trough is placed about the joint and the compound is poured in. Loose-fitting paper tubes are also employed to separate the phases. In a very few hours it is solid, and a great advantage is that current can be restored before the compound has set. It was pointed out that this method may be used in the neighbourhood of broken gas pipes or for cables in gaseous mines.

CARBON MONOXIDE.—The Department of Scientific and Industrial Research has issued a further leaflet in the series "Methods for the Detection of Toxic Gases in Industry," dealing with carbon monoxide. Among the industrial situations in which this gas may be encountered in dangerous concentrations are blast furnaces, brick kilns, chemical works, foundries, gas works, coke ovens, and lime kilns. Carbon monoxide is colourless and odourless and is, therefore, very insidious in its action. An atmosphere in which a concentration as low as 1 part in 2000 is present may prove fatal in about one hour to a person engaged in an active occupation. On the other hand, concentrations below 1 in 10,000 may be regarded as relatively harmless for all practical purposes. The standard method developed for the detection of carbon monoxide in industry consists in drawing samples of the atmosphere under test through a known area of test paper, treated with palladium chloride, at a slow and constant rate, by means of a 5 litre aspirator. This method enables interfering gases to be removed by allowing the sample first to pass through a tube of activated charcoal, Sampling is continued until a stain is obtained on the test paper which compares with the standard colour chart; the concentration present is then determined by comparing the time required to reach the necessary colour with the times given on the chart. In this way concentrations of 1 part in 500 can be detected in less than two minutes, and of 1 part in 10,000 in half-an-hour. Full instructions for carrying out the test, and the colour chart, are contained in the leaflet.

Air and Water

NEW YORK HARBOUR RETURNS.—The annual returns of New York Harbour show that during 1939 the number of ships arriving totalled 6011, with an aggregate net tonnage of nearly 29 million, of which 1850 were ships of American registry.

HIGH SPEED MOTOR TORPEDO BOATS.—A speed of over 48 knots was attained when on trials, carrying full war load, by some motor torpedo boats recently completed by John I. Thornycroft and Co., Ltd. The boats which are 55ft. in length are each fitted with two 12-cylinder petrol marine engines of a total of 1300 H.P.

EMPIRE AIR TRAINING SCHEME.—It has been officially announced in Australia that the British Government is to present between 300 and 400 Fairey Battle, and 500 Avro Anson machines to Australia for the Empire Air Training Scheme. These machines will form part of the fleet of 3000 aeroplanes, including replacements, which it is estimated that Australia will use during the next three months.

AMERICAN AIRCRAFT PRODUCTION.—In his report to the United States' Aeronautical Chamber of Commerce, the president, Colonel J. H. Jouett, said that the production of aeroplanes and engines in the United States during 1940 was expected to reach a value of over 500 million dollars. There is at present a reserve of unfilled orders to a total value of about 625 million dollars and of this amount 200 million dollars worth was for the American air forces.

A NEW PARACHUTE.—A new Italian parachute, known as the Salvator D39, which has been designed to reduce the shock of opening if the wearer has just jumped from a very fast machine, is described in a recent issue of *Flight*. The shock absorbing effect is obtained by means of a hole in the centre with an elastic rim which allows the hole to dilate and spill the air until some reduction of speed has occurred. Its total weight is said to be about 17½ lb.

SHIPPING CASUALTIES.—During the week ended Sunday, February 11th, three British ships totalling 19,585 tons and three neutral ships totalling 10,328 tons were sunk as a result of enemy action. Up to Wednesday, February 7th, the number of ships escorted in British Convoys since the beginning of war was 8284, and the number lost in convoy was 18. Of the 18 lost only two were neutrals, and one of these was sunk as the result of an attack by a U-boat. The U-boat was sunk by the escorting vessels and aircraft.

FRENCH WARSHIP CONSTRUCTION.—According to the French press there are at present under construction in that country four 35,000 ton battleships, two 18,000 ton aircraft carriers, three 8000 ton cruisers, 15 destroyers, ten submarines, and three submarine minelayers. In a recent statement M. Campinchi, the French Minister of Marine, said that one of the battleships, the "Richelieu" will be ready for commissioning after June next. The armament of this ship is stated to include eight 14in. guns, fifteen 6in. guns, and eight 37 mm. and ten 13 mm. anti-aircraft guns.

HIGH ALTITUDE FLYING.—In the photographic reconnaissance flights over Germany, the R.A.F. bomber aircraft have flown at altitudes up to five miles above the earth and on one flight temperatures as low as 52 deg. of frost were encountered. We understand that electrically heated flying clothing is no longer generally used by the crews on these machines who now rely almost solely upon warm clothing. To guard against risk of premature collapse it is now the usual practice for oxygen inhalation to begin at 10,000ft., the rate of supply being steadily increased as the altitude is increased.

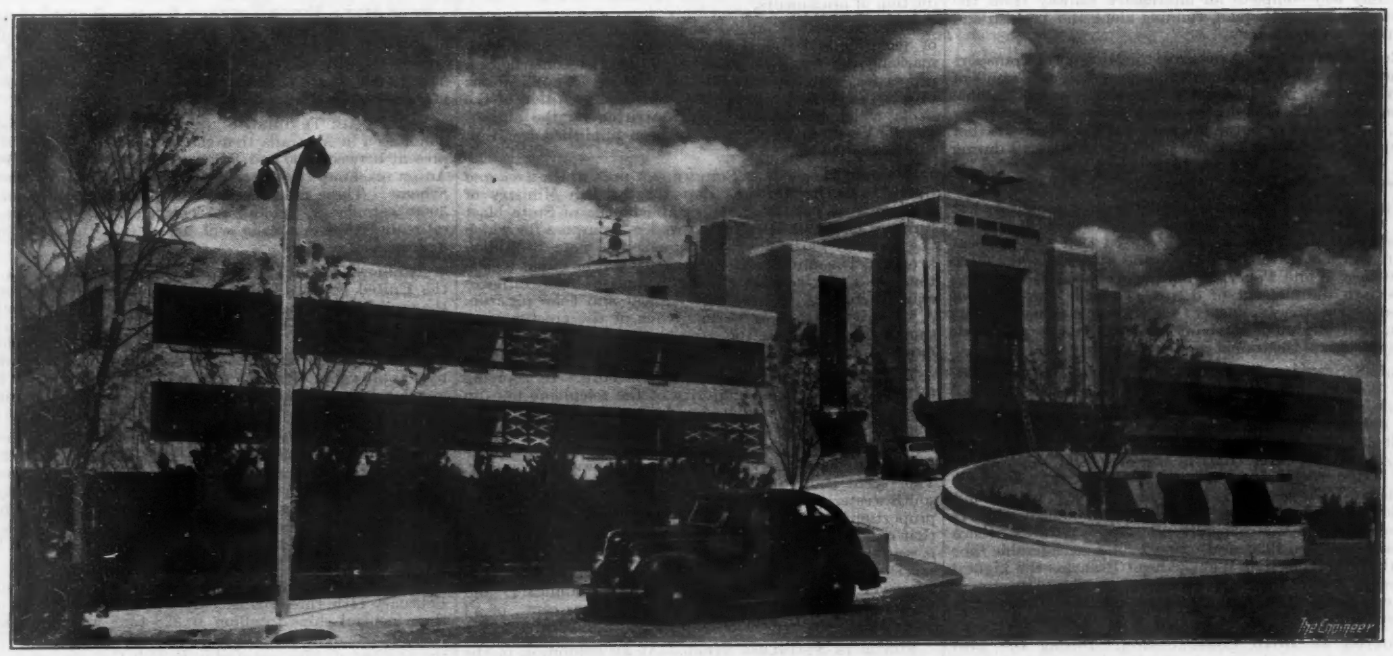
GERMAN ANTI-AIRCRAFT GUNFIRE.—German anti-aircraft gunfire varies in accuracy. The pilot of a machine which flew over Berlin reported that the defence organisation there must have been badly shaken. Not a shot reached home, although it was obvious that every available gun had been brought to bear on the visitor. For the most part the projectiles used in that case seemed to be experimental. Among the familiar ones generally used by the enemy are the "flaming onions," a string of balls of fire shot into the air in the presumed course of the aircraft, in the hope of setting it on fire. There are also what a pilot described as "incendiary shells." When they explode these shells discharge large red balls of fire that can be seen the whole way up. They eventually disappear without bursting.

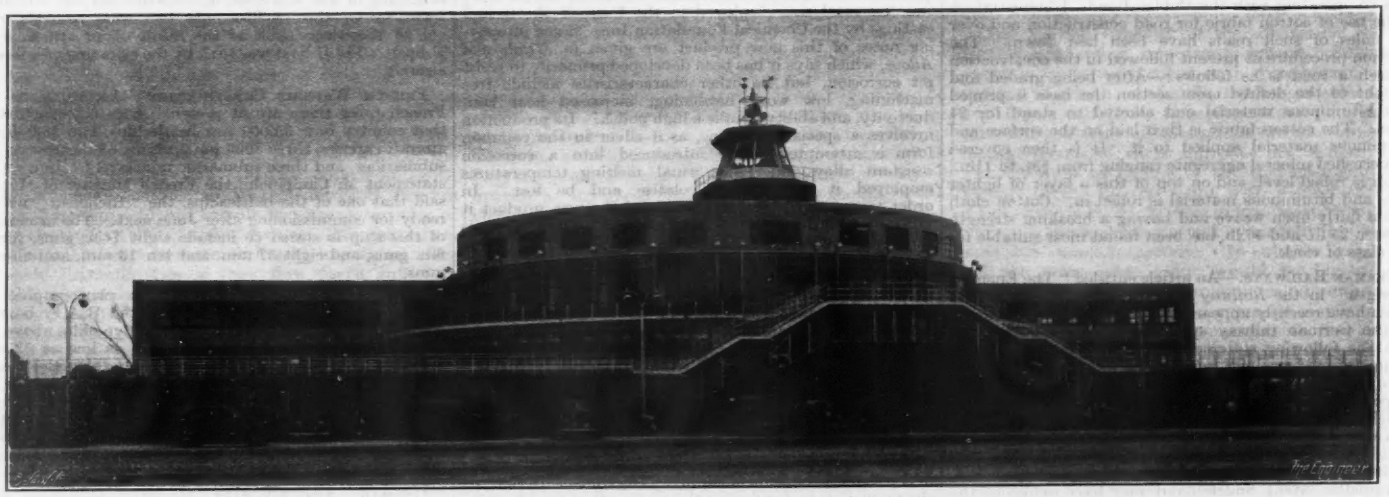
INSTITUTION OF NAVAL ARCHITECTS SCHOLARSHIPS.—A research scholarship of the value of £250 per annum, and tenable for two years has been founded by the Wrought Light Alloys Development Association to encourage and facilitate research in the application of light alloys to ship construction. The scholarship will be administered by a committee of the Institution of Naval Architects, and it is hoped to make the first award in September, 1940. Full particulars of entry, which closes on July 31st, can be obtained from the secretary of the Institution. The Council of the Institution has awarded the premium of the Institution for the year 1939 to Mr. A. Nicholls, for his paper "The All-Welded Hull Construction of H.M.S. "Seagull." The Wakeham prize for 1939 has been awarded to Mr. A. Emerson for his paper "The Effect of Shape of Bow on Ship Resistance (Part II)."

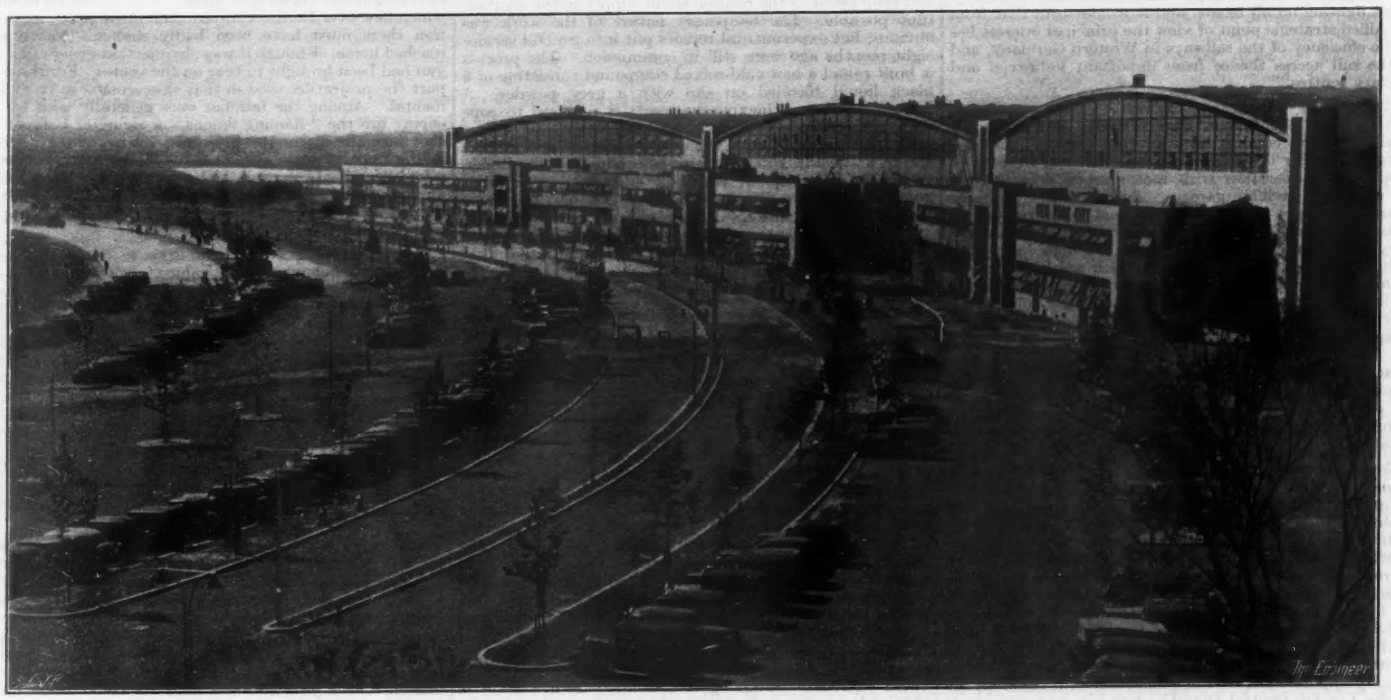
SHIPBUILDING FACILITIES IN AMERICA.—A report issued by the National Council of Shipbuilders on the shipbuilding facilities in the United States privately owned yards shows that there are 83 berths of 300ft. or more suitable for building sea-going ships. There are also 37 other ways in a state of partial dismantlement which could easily be made available if required. The active berths have a capacity of about 166 ships aggregating over a million tons a year and this capacity could be increased by 50 per cent. by the reconditioning of the other 37 berths. The survey showed that 62 of the active berths are on the Atlantic Coast, of which 40 can take ships of 500ft. and over; seven are on the Gulf, five of which are capable of accommodating ships of over 500ft. long; and 14 are on the Pacific Coast, of which seven can take ships of 500ft. In addition, there are 17 slipways occupied or available on the Great Lakes.

NEW YORK MUNICIPAL AIRPORT

(*For description see page* 174)







LANDPLANE ADMINISTRATION BUILDING—INLAND FACADE

LANDPLANE ADMINISTRATION BUILDING—LANDING FIELD SIDE

LANDPLANE HANGARS AND CAR PARK

The Engineer

FEBRUARY 23, 1940

VOL. CLXIX No. 4389

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PUBLISHING AND ADVERTISING

THE ENGINEER is now being published at the works of William Clowes and Sons, Ltd., Beccles, Suffolk. Telephone No. Beccles 2103. All correspondence connected with publishing and advertising should be directed to that address.

EDITORIAL

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GENERAL

The head office, 28, ESSEX STREET, STRAND, W.C.2, is open from Mondays to Fridays inclusive from 9-15 a.m. to 5-15 p.m., where classified advertisements may be handed in as usual and copies of the paper may be purchased. The office is not open on Saturdays.

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With a view to the conservation of paper, readers are advised, in the interests of all concerned, to place a regular order for THE ENGINEER with their newsagent or direct with the Publisher.

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*** *All letters intended for insertion in* THE ENGINEER *or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

*** *No undertaking can be given to return drawings or manuscripts; correspondents are therefore requested to keep copies.*

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AIRCRAFT OBSOLESCENCE

THE immense size of the Russian Air Force has for long been one of the uncertain menaces of the world, uncertain because although its size was sure its efficiency was doubtful. Now, through the struggle in Finland, much that was uncertain is slowly but surely revealed. It will only be fully revealed when Finland is in a position to put into operation the supplies of aircraft which have recently reached her or are now on the way. When that occurs the raiding of Finnish towns by hostile aircraft will become a very much more hazardous proceeding than it has been of late, though it is clear that even now a heavy toll is taken by A.A. guns. The losses of Russian aircraft are probably not less heavy through mistaken navigation leading to forced landings, and no doubt heaviest of all during the training of the unmechanical Soviet citizen to operate aircraft even of not the very latest type. Some of the Russian Air Force is known to be obsolete and it is quite likely that estimates of the size of that proportion may grow, should coming events reveal the fighting power of Russian bombers when resolutely opposed by relatively modern fighters in skilled hands.

Obsolescence is not found however solely in the Russian air fleet. It is a factor with which all have to reckon. It happens with armies and it happens with navies, although on nothing like so embarrassing a scale as in the case of aircraft. One knows, for instance, that any thousand aircraft anywhere to-day will be obsolete within five years—and some would call that a generous allowance of effective life. Any one year's models make those of the previous year or two look just a little odd, and when the difference in age is three years obsolescence is definitely in the air. This wastage, due to change of ideas, is therefore on an enormous scale, and so it must continue until design tends to become stabilised. At present a contest between two air forces is not solely or even mainly one of the fighting skill and determination of the two sides, for much still depends on whether some designer may have discovered a way of taking advantage of the laws of nature to get ahead of his rivals. It is as though in a game of chess, assistance to victory was afforded by employing very especially designed chessmen rather than on the usual battle of wit between the players. Will this situation last? Will it always be as much a struggle between designers as between the trained fighters? The answer is both "yes" and "no." Recent years have seen radical changes in aircraft design: the biplane gives place to the monoplane, the undercarriage is retracted in flight, the airscrew can vary its pitch whilst under power. What other comparable changes could there be? Objectives in aircraft construction still under aim must be in time attained in some measure and thence onward the only further improvements possible will be but minor. Have we yet reached that point in aeroplane design? In the long view, it must be admitted that while we retain tractor screws, use dangerous fuel, and employ recriprocating engines, that degree of advance can hardly be said yet to be fully attained. But much of the path of aerodynamic advancement has been trod and most of the rest at least partially explored. Speed changes, for example, are definitely limited by the compressibility of the air, and are fairly sure to be found close to the practical limit before this war is over. Much the same applies to the altitude of flight. But in respect of range there is great possibility of improvement once new metal alloys of previously unattained specific strength are discovered.

Someday, therefore, the competition between designs will be less in the field of speed and climb, and even of manœuvrability, than in that of equipment. The rivalry will then depend on the instrumental aids to military aims, on the ordnance carried, on the nature of defensive arming throughout. Obsolescence will come to depend upon equipment rather than on airframe or engine, and the wastage should therefore be far less costly. At the moment, practice varies greatly in respect of aircraft equipment: take for instance aircraft ordnance: some countries favour the "cannon gun" and some do not, and all can give good reasons for their views. It is curious that such an uncertainty has persisted for so long. It began in the Four Years' War when some belligerents experimented with the "Davis" gun, so dear to onlookers, rightly located, for it had the odd property of firing from both ends at once, a degree of impartiality between friend and foe which has made it for ever famous. Inventors are unfailingly ingenious, however, and we do not expect the Four Years' War to maintain any lead in this field over the hidden schemes of the inventors to-day, whether on ordnance surprises or in aught else.

Our Coal Supplies

EVER since Britain became an industrial country and began to draw extensively on its coal resources recurrent expression has been given to the fear that within a measurable period of time those resources would be exhausted, or at least depleted to such an extent as to put an end to our industrial activity on its present basis. For many years political economists, statisticians, presidents of learned societies, Parliamentary Committees and Royal Commissions have debated the subject without however reaching any approach to agreement on the answer to the all-important question, "How long will our coal resources last?" According to some of the earlier estimates we should at this present date be fast approaching the time when the diminution of our coal supplies should make itself unpleasantly felt. Other estimates, equally authoritative, but more optimistic, have placed the life of our coal fields, at the prevailing rate of demand on them, at anything up to a thousand years. It is to be feared that the patent disproof of some of the more alarming estimates and the latitude allowed by the more consolatory have induced in the modern generation an indifference towards the subject which is in very sharp contrast with the excited attention at one time given to it. Our own columns bear a record of the fact that in the late sixties of last century the fear that our fuel deposits would soon be exhausted reached the proportions almost of a panic, so much so that many voices were raised in support of the suggestion that the National Debt should be paid off while there was still time and the means for so doing. Those fears were not allayed until a Royal Commission on Coal had been appointed to enquire into the question and had published a report, tinged, we may now suspect, with studied optimism. The immediate result of that report was, as might be supposed, an outburst of unrestrained fresh exploitation of our coal deposits. In the four years from 1871 to 1873, the number of pits in the United Kingdom increased from 2385 to 3933. Yet within five more years there was a severe shortage of coal and, although the real reason for it lay in quite other causes, the old fear revived that we were squandering our resources to the point of imminent bankruptcy.

To-day, as we have said, we regard the subject calmly, perhaps a little too calmly. Complacency is induced by several factors. The wide variation of the estimates made in the past inclines us towards a general disbelief in the results of all efforts, old and new, to determine how long our coal supplies will last. Giving more thought to the subject we realise that the problem must be based on so many primary assumptions that it can hardly be regarded as determinate. Before we can solve it we must know two figures, one being the total amount of coal still available, and the other being the annual consumption at present and in the future. Doubtless at this date there remains but little chance that fresh great discoveries of coal will be made in this country. The locations of the main deposits are well known, but in estimating the amount of coal yet to be won at each we must exclude all that lies below a certain depth—the greatest depth at which it is possible for miners to work and from which it is commercially practicable to draw coal. In some of the earlier estimates that depth was taken to be in the neighbourhood of about one thousand feet. To-day, with the advancement of mining and engineering science, it would be safe

to place it at somewhere between three and four thousand feet. Even that figure will exclude as unavailable a large volume of coal deposits which with further technical developments, particularly in face of increasing pressure for supplies, might in the future be justly regarded as workable. To illustrate this point statistically we will quote some figures given by Mr. E. O. Forster Brown in his recent presidential address to the Institution of Mining Engineers. Since the beginning of this century Mr. Brown has kept personal records of all the collieries which he has valued or upon which he has reported. These collieries in the aggregate produce about one quarter of the country's annual output of coal. Their total reserves of coal in the seams being worked at the dates of examination were estimated to be about 2700 million tons, or sufficient at an output of 60 million tons a year for a life of 45 years. If, however, the survey be extended to include seams not being worked at the dates of examination but considered to be workable the total reserves rise to over 4400 million tons, or sufficient to last for 75 years. Obviously, however, a future generation may be able greatly to extend the "workable" limit and proportionately augment the total reserves and consequently prolong the life of the collieries. It would be a bold man who would attempt to forecast what developments the future will see in mining practice, and it seems to us that an equally bold man is required to assess the probable life of our coal supplies. Again, the figure arrived at must be considerably influenced by the assumed annual rate of output during the remaining life of the collieries. Many of the earlier estimates went astray on this point by assuming that the then current rate of increase in the output would be maintained unaltered year after year. An examination of one of the tables accompanying Mr. Brown's address shows how misleading such an assumption is in actual fact. During the ten years from 1890 to 1900 the annual output of coal in this country increased at an average rate of 2·4 per cent. per year. Over the next decade the rate of increase was 1·75 per cent. per year. From 1910 to 1920 the output *decreased* by an average rate of 1·3 per cent. per annum. The ensuing ten years saw a slight recovery, the average annual output showing an increase of about one half of one per cent. From 1930 to 1938 there was an average annual *decrease* of nearly one per cent. Put otherwise, a statistician in the year 1900 taking the average annual rate of increase over the previous ten years as his basis would have estimated the 1938 output at about 437 million tons, or very nearly twice the actual figure, which was 230 million tons.

There are a number of reasons why we should come to the conclusion that the problem of forecasting the life of our coal resources is insoluble. Its solution, as we have said, requires us to anticipate the developments and improvements likely to be made in mining practice. Also, quite obviously, it requires us to anticipate the effect on the demand for coal of a number of technical and commercial factors such as a reduction or increase in the export trade, the advent of alternative forms of fuel and improvements in the efficiency with which we use our coal. All these factors have had a material affect on the coal output of this country since 1900. Our exports of coal have greatly diminished during the intervening years, oil as an alternative fuel has grown from insignificance to a powerful rival, and the efficiencies of our prime movers and of nearly every process making use of coal, as a source of energy or otherwise, have been much improved. Regarded solely from the point of view of the exhaustion of our coal supplies we have been living since this century began in a fortunate period. That fact seems to have lulled in us the anxiety on the subject which our fathers and grandfathers felt in their days. We must, however, be prepared to find that the good fortune of our age will not continue indefinitely, and that there is a limit below which it is impossible to reduce the demand on our coal resources. How long will they last? Mr. Brown mentions two alternative figures—45 and 75 years—even the higher of which is alarming. Our own opinion is that the problem remains as insoluble as ever. There is no consolation in that conclusion. An insoluble problem is not, as some people think, a problem for which no solution exists, it is one which we, with our strictly limited ability to attack it, are unable to resolve. Our failure to determine the length of life still remaining to our coal fields, and through them to our national prosperity, does not in any way diminish the importance of the problem. Rather, it may well be said, does it increase its importance.

Sixty Years Ago

ARTHUR JULES MORIN

MORIN'S "Laws of friction," although a little discredited nowadays are still familiar, by nature at any rate, to students of engineering and physics. But who was Morin? Most of us would find it difficult or impossible to answer that question. Yet when he died, at the ripe age of 85, sixty years ago, he was described in our columns as a distinguished son of France whose name was widely and favourably known as a great experimental investigator in every part of the world where exact science in its practical applications had penetrated. Morin was intended by his family and friends for a military career, but Napoleon's defeat at the battle of Leipzig in 1814 led to the turning of his attention to the scientific rather than the practical side of the profession. Thus after completing his course at the Ecole Polytechnique and receiving his commission as a Captain he proceeded to Metz, at that date renowned as a great school of applied science. There he accumulated a vast store of knowledge. In 1828 he received his first public appointment as a scientific officer, the occasion being his recommendation by the Minister of War to take charge of an investigation into the prime movers employed in the Government factories as compared with those in private establishments. His merits becoming recognised as a result of that enquiry he was appointed in 1830 to the professorship of Applied Mechanics at Metz. In 1831 he published the results—the celebrated "laws"—of a series of experiments on friction, a subject which until that date had in its practical aspects been much neglected by all save Coulomb. The Government factories on which he had reported were completely destitute of steam engines, their motive power being derived exclusively from water wheels or horse mills. As a result Morin developed an interest in hydraulic power, and in collaboration with Poncelat, who had just invented the undershot wheel with curved buckets, he did much to promote progress in that direction. Other subjects which attracted his versatile genius were the cohesion of masonry, the design of a dynamometer for continuously registering the outputs of prime movers, and the effect of traction on the wear of roads. In 1841 he was appointed a professor, and later the director of the Conservatoire des Arts et Métiers at Paris. While holding that post he published numerous scientific works and was the constant adviser of the Government on scientific subjects. The establishment of the Second Empire in 1848 and the activity of the Emperor Napoleon in reconstructing Paris and other large cities gave Morin fresh opportunities for the employment of his abilities, one of the most notable directions in which he was employed being on the design of an improved system of ventilating and lighting the Lyrique and other theatres which the Emperor's schemes had called into being. Morin had now reached the rank of a General of Division. His technical skill and organising ability were enlisted in connection with the great international exhibitions at Paris in 1867 and 1878, and did much to contribute to their outstanding success. As an abstract mathematician he did not reach the standard of such men as Poisson, Navier, Lamé, or Saint-Venant, but he excelled them and others in the discernment with which he could seize upon the practically useful information that was hidden in an apparently inextricable maze of symbols. In person Morin was square-built, powerful, and above the average height. In manner he was genial and affable with rather more of the grave and thoughtfully ponderous than was commonly supposed to characterise his countrymen.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

AUTOMATIC TRAIN CONTROL

SIR,—I write to express my appreciation of your recent series of articles entitled "Modern Railway Signalling Practice."

Your all too brief description of the G. W. and of the Hudd systems of automatic train control are of especial interest in that, whilst serving my apprenticeship, I was for a while employed upon an automatic control system developed by the old Great Eastern Railway Company—later the G.E. section of the L.N.E.R. This system was, I believe, known by the name of "SYX" and at the time of the trials appeared to be so successful that it would be of interest to learn why it was shelved.

As in the G.W. system, a ramp was installed between the rails and the locomotives carried collector shoes. The ramps were of two types, that at the stop signal being somewhat higher than the distant signal ramp, and the upward movement of the collector shoe mechanically operated brake application and audible warning devices. If the ramps were energised for the "all clear" position of the signals the electric current picked up by the shoes held the brake application valve and the warning device inoperative. On approaching a distant signal at danger the collector shoe was raised by the ramp and the warning device sounded by the air escaping from the train pipe due to the partial application of the brake. The driver had to acknowledge this signal by means of a cab control in order to silence the warning and to release the brakes. At the stop signal ramp the collector shoe was raised through its full travel, the warning signal again sounded, a "full" application of the brakes was made, and, the train being brought to a dead stop, the driver had to dismount and go to the collector shoe carrier to reset the apparatus. As has been said, the ramps were energised to prevent the brake applications in the "all clear" position of the signals and thus any failure of current supply ensured that the "caution" or "stop" brake applications were made.

Years have passed since I was in any way connected with the system and I have drawn upon my memory for these brief notes. If any reader can amplify them, or throw any light upon the fate of the "SYX" system of A.T.C. it will be of interest.

E. B. PARKER.

Wirral, Cheshire.
February 12th.

DRYING OUT FLOODED ELECTRICAL MACHINERY

SIR,—With reference to my letter published in your issue of February 9th, I referred to the Dolgarrog power stations as being the property of the North Wales Power Company. My attention has been drawn to the fact that at the time of the flood (1925) the plant belonged to the Aluminium Corporation, Ltd., and it was not until 1929 that the stations were taken over by the North Wales Power Company, Ltd.

GEOFFREY GERARD, A.M.I.E.E.

Kirkcudbright.

BOOKS RECEIVED

Water Treatment. By G. V. James, M.Sc. London: Technical Press, Ltd., Ave Maria Lane, E.C.4. Price 30s. net.

The "Motor Ship" Reference Book, 1940. London: Temple Press, Ltd., Bowling Green Lane, E.C.1. Price 5s. net.

Surveyor's Trek. By David Anderson. London: Faber and Faber, Ltd., 24, Russell Square, W.C.1. Price 10s. 6d. net.

Electrical Technology. By H. Cotton, M.B.E. Fourth Edition. London: Sir Isaac Pitman and Sons, Ltd. 1939. Price 12s. 6d.

Engineering Reorganisation. By J. J. Gillespie. London: Sir Isaac Pitman and Sons, Ltd., Parker Street, W.C.2. Price 12s. 6d. net.

Principles of Electric Arc Welding. By I. H. Child, B.Sc. Epsom: Draughtsman Publishing Company, Ltd., 1, Links Road. Price 2s. net.

The Superheterodyne Receiver. By Alfred T. Witts, A.M.I.E.E. Fourth Edition. London: Sir Isaac Pitman and Sons, Ltd. 1939. Price 4s. 6d.

Short-Wave Radio. By J. H. Reyner, A.M.I.E.E., M.Inst.R.E. Second Edition. London: Sir Isaac Pitman and Sons, Ltd. 1939. Price 10s. 6d.

The Corrosion of Iron and Steel. By J. C. Hudson, D.Sc., D.I.C. London: Chapman and Hall, Ltd., 11, Henrietta Street, W.C.2. Price 18s. net.

Engineering Design. By J. E. Taylor, A.M.I. Mech. E., and J. S. Wrigley, A.M.I. Mech. E. London: Sir Isaac Pitman and Sons, Ltd. 1939. Price 10s. 6d.

Symmetrical Component Analysis of Unsymmetrical Polyphase Systems. By R. Neumann. London: Sir Isaac Pitman and Sons, Ltd. 1939. Price 21s.

Records and Research in Engineering and Industrial Science. By J. E. Holmstrom. London: Chapman and Hall, Ltd., 11, Henrietta Street, W.C.2. Price 15s. net.

Present Status and Trends of Engineering Education in the United States. A report prepared by D. C. Jackson. New York City: Engineer's Council for Professional Development, 29, West 39th Street, Emergency Addresses Directory. London: Cresco, Ltd., 76, Chancery Lane, W.C. Price 1s. net.

Obituary

COL. R. E. B. CROMPTON

IT was announced on February 15th that Colonel R. E. B. Crompton had died on that day in his ninety-fifth year, at Azerley Chase, Ripon. Thus the world has lost one who throughout an exceptionally long career played a dominant role in engineering, and by his genius, personality, and ceaseless energy had become one of the most notable characters in the field of engineering.

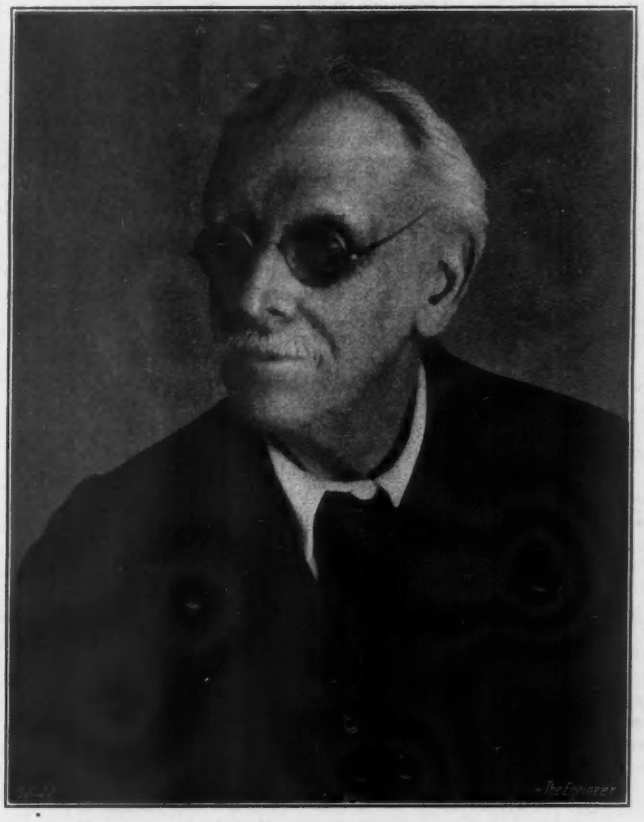
Rookes Evelyn Bell Crompton was born on May 31st, 1845. His father, Joshua S. Crompton, was a Yorkshireman and his mother a Scot. When six years old he was taken to see the Great Exhibition of 1851 in Hyde Park, the journey being made by special exhibition excursion train from Thirsk to London. When still under the age of eleven years he was, having actually been in the firing line, awarded the Crimean Medal and Sebastopol clasp. Returning to England, he left the Navy and went to Harrow School in September, 1858. During the holidays of several years and subsequently whenever he could find time, he worked on the construction of a steam-driven road locomotive, "Blue Bell." Having served for some time at Doncaster under Sturrock, of the Great Northern Railway, he sat for the Army examination, which he passed equal-second, and was gazetted in April, 1864, as an ensign in the 3rd Battalion of the Rifle Brigade, being then only nineteen years of age.

The young officer accompanied his regiment to India at the end of 1864, whither he had sent out to him his machine tools and the parts of his uncompleted road engine, which he finished and set to work. Without going into details, it will be sufficient to say that, as the outcome of his work in the direction of mechanical road transport, he was "seconded" from his regiment in 1870 in order to take up the position of "Superintendent of the Government Steam Train" under the Director-General of the Post Office. A steam locomotive had previously been ordered from Mr. R. W. Thomson, of Edinburgh, who had had considerable success in designing road vehicles. The engine worked well, but it was found that the boiler—originally designed for coal—was incapable of raising sufficient steam when using wood as fuel. Crompton was thereupon ordered to return, to England to confer with Thomson with the object of designing a boiler which would operate under the conditions in India. Three engines, in which Field boilers were used, were eventually constructed, and the first was sent out to India in 1871, Crompton himself returning to that country in the following year. The engines proved entirely successful, and once, when giving a demonstration, the young man and his work attracted the attention of Lord Roberts—a circumstance which was, later, to have important results.

In 1875 Crompton, in accordance with Army regulations, had to return to his regiment, and he received a special grant of £500 in recognition of his services in connection with steam road transport. He came back to England, and in 1876 was gazetted out of the service, with the rank of Captain. In the same year he entered into partnership with T. H. P. Dennis and Co., of Chelmsford, who were at that time specially interested in a new form of valve for use in heating apparatus. For a time he largely acted as a commercial traveller selling those valves. Finding it necessary, however, to supplement his earnings from that source, he practised, for a time, as an independent engineer, among other things, helping the late Mr. Peter Willans in designing tramcars fitted with the latter's engines.

In 1878 he was employed in laying out a foundry for the Stanton Company, on the board of which he was, some months later, given a seat. Trouble having been experienced concerning the lighting of the works for night shifts, he obtained permission from his directors to import some Gramme electric machines and lamps—and the success achieved with them at the Stanton works was so striking that it attracted a great deal of attention. It may here be recorded, though it is out of order chronologically, that he later employed at the Stanton works high-speed engines driving directly on to line shafting, without the intervention of belting. He believed that it was the first time that that had been done. This essay in electric lighting gave him the idea of, himself, becoming a manufacturer of electrical machines, and so he founded the firm of Crompton and Co., with headquarters at Chelmsford.

Fully to trace the history of that undertaking and of the large part which its founder played in its fortunes during his long connection with it, would be impossible in the space at our disposal. The mention of a few facts will have to suffice. Operations were begun in quite a small way in a room over the brass-foundry in Dennis and Co.'s yards.



COLONEL R. E. B. CROMPTON

The first business was to remodel the Serrin arc lamp so that it might not cast shadows downwards. Then, the sole right to manufacture and sell Bürgin type dynamos having been obtained, the making of such machines was undertaken and their design improved. It was found that, as the design was bettered, as many as six to eight arc lamps could be run in series from one machine, which put the firm into the position of being able to light such places as railway stations. The first station to be illuminated in that way by the company was St. Enoch's at Glasgow, a work which brought Crompton into contact with Lord Kelvin, then Sir William Thomson. The lighting of other railway stations, and of buildings for other purposes, followed quickly. Machines suitable for portable lighting sets were also designed, notably as early as 1879 one for Marshalls, of Gainsborough. One of such sets was used at the Henley Regatta in 1879.

Up till that time, of course, the arc lamp was the only means of obtaining light—commercially—by means of electricity, but the introduction of incandescent lamps was about to take place. Their advent, and the consequent demand for machines capable of supplying them with current led Crompton in 1880 to increase the size of the Chelmsford works. Exhibits of its plant were sent by the company to the International Exposition held in Paris in 1881 and received what is said to have been the first gold medal ever given for electric lighting plant. Crompton-made Bürgin machines were, about the same time, also supplied for the transmission of power from the falls at Rheinfelden. The firm also received the order for the internal lighting of the Crystal Palace for the Electrical Exhibition in 1882. In the same year a permanent installation for electric lighting was put in by it at the Mansion House.

About this time, Crompton, with the object of improving the design of dynamo-electric machines, hit upon the idea of using wrought iron of large cross section for the cores of the magnets. The very first machine constructed in accordance with his new plan was a great success. Then he discovered that, by using twisted and stranded wires for armature windings, he considerably reduced Foucault losses and improved the efficiency of the machines. During the same period, too, he coupled a high-speed Willans engine directly to a dynamo for the lighting of the Brazilian warship "Aquidaban," and he claimed that that was the first occasion on which such a combination had been employed.

As a consequence of the Crystal Palace Exhibition the firm received several large orders, including that for the lighting of the Royal Courts of Justice. That "job"—to use Crompton's own words—"was the first really large installation for electric lighting with incandescent lamps to be put down in this or in any other country." It led to many further orders, including those for installations in the house of Sir Richard Webster—afterwards Lord Alverstone—and Sir William Crookes. Almost at the same time, Crompton got out designs for the building of central electricity supply stations near Victoria Station, in the Strand, and near Hanover-square. Only the first named was actually constructed.

The year 1882 also saw the foundation of the Dynamicables, which still flourishes, Crompton being an original member. The name he described as a portmanteau word, "suggesting the dining amicably together of persons dealing with dynamos, cables, and mica."

The fire which in 1883 destroyed the Ring Theatre at Vienna, and the subsequent reconstruction of that building, gave Crompton a chance to carry out on a large scale an experiment on the distribution of electrical energy from a central point over a wide area. He obtained the order, and a site nearly a mile away from the theatre was chosen for the generating station. In order to transmit current with the least possible loss over that considerable distance a five-wire system was evolved. Current was generated at about 440 volts and was conveyed at that pressure to a point near the Opera House. There, there was an accumulator battery, from different points in which five separate cables were led to the points where current was required, the arrangements being such that there were four separate circuits, each with a potential difference of 100 volts between pairs of conductors. There were six Crompton-Willans generating sets, each with a 150 H.P. engine. No station of as large a size was laid down in any part of the world till some years later. The equipment for the electric lighting of the Burg theatre followed that at the Opera House. This and other work necessitated a lengthy stay in Vienna on the part of Crompton, and his firm opened a branch office in that city.

The success of these installations led to invitations being extended to Crompton to visit numerous continental cities to advise and report. He was consulted, sucessively, by Budapesth, Gothenburg, Stockholm, Copenhagen, Belgrade, Vienna, Ventimiglia, and Sofia, and as a result obtained several remunerative orders for his company. In this country he was concerned with the founding of the Kensington Court Electric Supply Company, which began sending out current to consumers at the end of 1886. The generated pressure was 220 volts, a a battery of 100 cells was employed, and a three-wire system of distribution used. The conductors were bare strip copper stretched on porcelain insulators in an existing subway. It may here be recorded that, later, Lane Fox and John Hopkinson sued the company for using three and five-wire methods of distribution, alleging infringe-

ment of patents. The courts, however, decided in its favour. Soon after this station was completed, Crompton built himself a house in Kensington Court, and there he set up a private workshop and laboratory for his own use. That laboratory was, later, to be the scene of a great variety of experimental works, one being the designing, in collaboration with Mr. Clements, of the Birmingham Small Arms Company, of a set of screw threads of a new form for the British Engineering Standards Association in 1901.

Crompton was always a staunch supporter of supplying electrical energy for lighting purposes in the form of direct current, the generating stations being situated in the centres of densely populated areas. His great opponent in the early days was Ferranti, who advocated the generation of alternating current in suitable sites and the transmission of the energy at high pressure perhaps over long distances to the areas in which it was to be distributed and used. In this "Battle of the Systems," which followed the amending Lighting Act of 1889, both Crompton and Ferranti played leading parts. As an aid to the manufacture of batteries of a more lasting type than those previously existing to be used in connection with his method of supply, Crompton in conjunction with Mr. J. C. Howell developed a new type of plate, known as the Crompton-Howell, which was claimed to be a great improvement on anything previously known.

In 1895 Crompton was President of the Institution of Electrical Engineers. In 1896, and again three years later, he revisited India, both times on electrical business. On the first occasion he went on the invitation of the Indian Government, which desired his assistance in the preparation of an Electric Lighting Act on lines similar to those of the British Act. He took the opportunity of being on the spot to choose the site for the Calcutta Central Station, which his firm equipped, and to attend the opening of which he again went to India in 1899. While there, he visited Kashmir, at the request of the Viceroy of India, to report on the possibilities of a new route for a railway into that territory over the Banihal Pass.

The years between 1896 and 1898 saw the formation of a Corps of Electrical Engineers as a volunteer branch of the Royal Engineers, and in the founding of that body—designated, for short, E.E.R.E.V.—Dr. John Hopkinson and Crompton figured prominently. As officer in command, Crompton, shortly after the outbreak of the Boer War in 1899, was asked to take a detachment of the Corps to South Africa to supply the electrical needs of Lord Roberts' armies. Properly to tell the story of the exploits of those volunteer electrical engineers during the continuance of hostilities would require volumes, and we shall not attempt it. The unit did all that was required of it in connection with electrical matters, and, in addition, did much which had nothing to do with electricity. Thus, it assisted largely in reconstructing destroyed railways and in repairing bridges. On one occasion —at Leeuwspruit—a detachment under Crompton was attacked by the Boers, and though it suffered numerous casualties, the enemy was beaten off. That comparatively small action saved Lord Roberts' army, as he himself declared to Crompton, who had been summoned to headquarters to report on the affair. It also had another important result so far as Crompton was concerned. Lord Roberts, when they met, remembered the work in connection with steam road vehicles which had been done in India a quarter of a century before, and appointed Crompton to reorganise the Mechanical Transport Corps. To hasten matters in the provision of the necessary vehicles, Crompton was sent back to England at the end of 1900, and did good work in the designing of lighter types of traction engines, in which steel castings and forgings were substituted for cast iron. Much more might be written regarding his activities in this direction, but we must rest content with just the foregoing brief mention of them.

One result of his service in South Africa was to quicken Crompton's interest in road transport by mechanical means. He had always been an enthusiastic bicyclist, and was a strong advocate of the use of longer cranks for the pedals. He himself used cranks which were 9½in. long, 3in. longer than the usual. First his bicycling and then the increasing use of the motor car led him to devote even greater attention than he had previously done to the condition of road surfaces. On the formation of the Road Board in 1910 he was made Engineer of it, and in that capacity carried out many investigations as to the dust-raising character of different forms of road vehicles and to the wearing qualities of different types of road surface materials. To avoid loss of time in experimenting with these different materials in actual service, he instituted a series of mechanical tests in his own laboratory with excellent results. On account of the experience which he gained in that way and by years of constant contact with questions of road construction and maintenance, his advice was sought in many directions, and some two years before the outbreak of the Great War he was called in to advise with regard to roadways in North-Eastern France.

Among the services which he rendered during the Great War must be mentioned those regarding the standardisation of the screw threads of projectiles so that the constituent parts might be absolutely interchangeable. Then, too, he was lent by the Road Board in order to serve on a Committee appointed by Mr. Churchill in 1915 to devise self-propelling vehicles capable of crossing trenches. In order to make himself acquainted with actual conditions in Flanders, he visited the front. He also made a careful study of various types of chain and other tracks, of special steel plates to resist rifle fire, of engines suitable for propelling the vehicles and a large number of other matters. Designs for "landships"—as they were termed—were finally got out, only to be scrapped and begun again. He claimed to be the first to suggest the use of two engines, one to control each track separately—a system which was embodied in the "Tanks" that were actually used on the various fronts.

In the foregoing we have made reference to the leading features in this life of extraordinary activity and diversity; but we have by no means come to the end of the list. It would, in fact, be difficult to do so within reasonable limits. It may be said, however, that Crompton took great interest in the development of road motor vehicles of all classes; that he was an original member of what eventually became the Royal Automobile Club, and acted in 1903 as one of the judges at the first Motor Car Show which was organised by that institution; that he was the first President of the Institution of Automobile Engineers and Chairman of the Commercial Motor Users Association. In addition to being President of the Institution of Electrical Engineers, he was a member of the Institution of Civil Engineers and of the Institution of Mechanical Engineers, and served on the Council of the former. He severed his connection with Messrs. Crompton and Co. in 1912, but he kept up his interest in electrical matters to the end, and a notice regarding him would be incomplete if reference were not made to the part which he played in the formation and work of the International Electro-Technical Commission.

It inevitably happens that as years increase upon famous men they lose touch with their old interests and cease to influence the new generations that arise around them. That was true of Crompton, but being endowed with excellent health and astonishing vitality he remained for more than the ordinary span an outstanding figure in the electrical industries. We recall a banquet given by the five major Institutions to commemorate his ninetieth birthday, and still remember the firmness of voice with which he acknowledged the reception of the toast by the large company, and thanked the donors for a portrait in oils, by George Harcourt, R.A., which was presented to him.

In the annals of electrical engineering, Crompton will always be remembered as one of the greatest pioneers. He was essentially a practical engineer and his success in electrical engineering as in road traction sprang from his zeal for making things and trying them. Such men are essential to the development of new industries.

We ought to add that in 1928, Constable and Co., Ltd., published a volume of Reminiscences by Colonel Crompton from which much of the information contained in this Obituary has been taken.

LOUIS TRENCH

There died on January 30th at a great age—ninety-three—Louis Trench, who was the first chief engineer of the Great Western Railway. The statement that he was a pupil of either George or Robert Stephenson, which has appeared in some quarters, is erroneous. After graduating at Cambridge, he served as a pupil with James Barton, an engineer in private practice in Ireland and he was engaged on the construction of the Dundalk, Newry, and Greenore Railway. When that railway became the property of the L. and N.W. Railway, Louis Trench migrated to England and was employed by that company on the construction of a number of important works. Afterwards as a divisional engineer he was in charge of the maintenance of the South Wales division, and later of the Birmingham division.

In the early nineties he was appointed the first chief engineer of the Great Western Railway. Whilst he did not stay many years at Paddington, he obtained some kudos by the good organisation which allowed of the last section of the Broad Gauge being converted to Standard with very little delay to traffic. His retirement from the company was owing to some disagreement which led to his resigning his appointment; it may be that as a reformer he was too hasty, or, it has been suggested, perhaps his Irishman's dislike of "compromise" wentill with the Englishman's love of that quality. Anyway he left and went back to the L.N.W. Railway.

In 1894 he supervised the construction of the Heaton Lodge and Wortley Railway in Yorkshire with Mr. Ernest C. Trench, P.P.Inst. C.E. as one of his assistants. Subsequently he went to Euston as chief assistant for new works to Mr. E. B. Thornhill. Mr. Thornhill retired in 1909. Louis Trench was then 63 and had he been a younger man, he would undoubtedly have succeeded as chief engineer. As it was he was thought to be too old and the appointment was given to Mr. Ernest Trench. This must have been a disappointment to him but he showed no sign of it and continued as new works assistant under his distant cousin who was 23 years his junior and had learnt most of his engineering from him. They worked happily together until Louis' retirement two years later.

Louis Trench was an engineer of outstanding ability, and a man of strong and upright character. He never learned to suffer fools gladly and some may have thought him a little uncompromising in his outlook on life; but he never did a mean act in his life and amongst those who had won his confidence he was held in high esteem and affection.

OSCAR HOWARD BALDWIN

THE death of Mr. Oscar Howard Baldwin, at the age of 78, occurred at his home, "Fairmount," Salcombe, South Devon, on Wednesday, February 14th. Oscar Baldwin received his education and training in America, and graduated at the Stevens Institute of Technology, Hoboken, New Jersey, as a mechanical engineer. After serving a short time with the Pennsylvania Railway, he joined the firm of Westinghouse, Kerr and Co., which later became the Westinghouse Electric and Manufacturing Company. After being chief engineer in the lighting plant of Plainfield, New Jersey, for a year, he rejoined the Westinghouse Electric and Manufacturing Company and was chosen by the late George Westinghouse to look after its British interests. From 1889 to 1893 he was engineer of the Westinghouse Electric Company of London, and had charge of the engineering work of the firm, including the erection of the new plant at the Sardinia Street Station of the Metropolitan Electric Supply Company. In 1893 he returned to America for a year to take charge of the electrical exhibit of the Westinghouse Company at the World's Fair, and a year later was given charge of the foreign sales department of the company. About 1898 the offices of the Westinghouse Electric Company, Ltd., of London were established at 2, Norfolk Street, Strand, and Mr. Baldwin became the managing director of the firm. From 1900 to 1902 he was managing director of J. and G. White and Co., Ltd., of London. Eventually the Westinghouse Electric Company, Ltd., of London, became the British Westinghouse Electric and Manufacturing Company, Ltd., and works were built at Trafford Park, Manchester. Mr. Baldwin remained at the London office of the firm and became the district manager of the company. When the name of the company was changed to the Metropolitan Vickers Electrical Company, Ltd., he still remained at the London office, and for some years he was also joint European manager of the Westinghouse Electric International Company. He retired about 1920, and for a time went to live at Salcombe, South Devon. In 1927 he was entrusted by the Taylor Stoker Company, of America, with the management of its interests in England, and when the British company was formed he became director in London. Mr. Baldwin remained a director of the company till he finally retired in 1933.

Oscar Baldwin will be remembered by many electrical, power station, and tramway engineers, as an able business man who had a charm of character which endeared him to many friends, both in this country and America.

Spot Welding of Light Alloys

THE welding of light alloys is a much more difficult and delicate task than the welding of steels. In general, they are good conductors of heat and electricity, their melting point is low and close above the temperature at which they soften and can be welded. At normal temperatures most of them are easily corroded and more so when they are heated. With some light alloys, the structure alters when they are raised above a certain temperature and special heat treatment is necessary to restore them to the normal condition. After long exposure to air, the surface of light alloys becomes coated with a thin film of oxide, very hard and very adherent. While forming a good protection for the metal, this presents the disadvantage, from a welding point of view, that the film has a very variable resistance value. Hence the welding of these alloys presents special problems which are considered in a recent publication issued by Philips Industrial (Philips Lamps, Ltd.).

Since the variations of contact resistance arising from the oxide film can be considerable, it is desirable to eliminate the film to ensure regularity in welding. This should be done not too long before the welding operation by pickling the metal in a suitable acid when reliable contact can be obtained between the two sheets. As the heat produced by the passage of current through the alloy is low, the waste of heat by conduction is high and the use of considerable electrical power is necessary. While sheet steel is usually welded with a current density of 80 to 200 amperes per square mm., light alloys require a current density in the neighbourhood of 2000 to 3000 amperes per square mm. To reduce the power needed for welding, research has been carried out with a view to reducing to a minimum the contact pressure between the pieces to increase the resistance. By this method the speed of the weld has been increased considerably, but a small variation in pressure is then liable to cause a big variation in contact resistance and therefore also in the regularity of the welds. Means of control of the electrodes have therefore been devised to ensure a very constant pressure and the results have been greatly improved.

Experience with certain steels led to the conclusion that it was necessary to weld aluminium alloys by adopting very short current times, but while in the case of stainless steel this offers the important advantage of avoiding carbon precipitation, no similar advantage is gained with light alloys even when used in the annealed state. Moreover, examination of the shape of the metal affected by the heating shows that this is flatter when the speed of welding is higher. While it is not at present possible to say with certainty what is the most favourable shape for the core of the metal affected by the welding current to give the best tensile strength and resistance to fatigue, it can be asserted that the core should never extend to the outer surface of the sheet as there is then a tendency to electrolytic corrosion between the core and the parent metal. It is generally taken that the weld core should not exceed two-thirds of the metal thickness.

The metal in the region of the welding spot forming the core of the weld, having been raised to a temperature near the melting point, is likely, on cooling, to have mechanical properties differing from those of the surrounding metal and this will be particularly noticeable in the case of heat treated alloys. This difficulty is overcome in the case of steels by applying a high pressure at the end of the welding period in order to harden the heated metal. But during the actual weld a lighter pressure is desirable to avoid reducing the contact resistance, with consequent increase in the power required. At the beginning of the welding period a higher pressure is used momentarily to ensure that the two pieces properly meet. But while this double pressure variation gives good results in the case of steels, it is not of much practical value for light alloys, because the vastly increased speed of welding makes it impossible to synchronise the pressure variation with the passage of the current. The pressure depends on the operation of a valve and the filling of a compressed air cylinder, and the time of these operations is much longer than the times employed for light alloys on modern machines; in fact the time variations of these operations is actually comparable with the welding time.

A slight improvement of the structure of the metal can be obtained by applying a pressure nearly the ultimate strength of the metal during the weld, for by this means the melted projections between the sheets can be almost entirely avoided. While the disadvantage of increasing the pressure is that the power necessary for the weld is considerably increased, the regularity of the weld is improved and any possibility of burning or perforating the metal is completely removed. The small difference between the softening and melting temperatures of light alloys makes it essential to control with great accuracy the amount of heat supplied to the weld, and this control becomes more difficult as the power is increased. Good results depend entirely on the application of the proper pressure and electrical power and in maintaining the absolute regularity of these factors. A good automatic timer working on mechanical principles and operating a contactor kept in a perfect state of cleanliness will give with most alloys good results, but only at the cost of high maintenance. To avoid this cost electronic timers have been developed and with their aid absolutely accurate repetition is ensured. A high production speed can be maintained without difficulty and maintenance costs are comparatively low, though care is needed, especially when starting up the apparatus.

To weld aluminium alloys at the high electrode pressures shown to be desirable, considerable instantaneous power is required. To weld 2×16 S.W.G., for example, it is necessary to use 200 kVA, and 350 kVA for 2×12 S.W.G. pieces, and loads of this nature may cause considerable voltage fluctuations on the mains. Various methods have been devised to overcome this disadvantage, but a method claimed to be relatively cheap and convenient is to store the energy in an inductance or condenser as used by Philips Industrial, Ltd., for nearly two years. Both these systems can be made to give a high current discharge in hundredths or thousandths of a second whilst the preliminary energising of the systems can take place a hundred times more slowly, giving an insignificant peak load on the mains. The condenser storage system, which incidentally has a much higher efficiency than the inductive system, requires only 20 kVA to weld 12 S.W.G. under the best conditions. This method has the additional advantage that it is possible to control with great accuracy the amount of heat generated at the weld. The electrical energy stored in the condenser is discharged through the welding electrodes without possible cause of irregularity. This system enables machines to be constructed which give consistent results, have a good efficiency, and are easily maintained. With certain light alloys with structures affected by heating, it is a great advantage from the point of view of stronger welds if the weld spot is cooled as quickly as possible after the weld has been made. From this point of view a condenser storage machine has the advantage that the current flow can be easily cut off whereas the asymptotic discharge of the induction machine cannot easily be shortened.

The diagrams, Figs. 1 and 2, show the operation of welding machines designed on the electrical storage principle. Referring to Fig. 1 there are two distinct parts to the operation, the first being the charging and the second the discharging of the condensers, the times of these operations being quite independent of one another. After a short initial period, the charging process is virtually independent of the time. There is no current to be interrupted and consequently no wear on the change-over switch. As the leakage loss of the condensers is comparatively slow, within reason, the length of time between the charge and discharge does not matter. A contactor with only a small movement starts the discharge, and there is no chance of it rebounding once contact has been made. When the contactor opens again it does not have to break any appreciable current because the discharge is virtually completed.

The amount of energy supplied to the weld clearly only depends on the amount stored by the condensers, *i.e.* $\frac{1}{2}CV^2$, which is a function of the capacity of the condensers and the voltage to which they are charged. To alter the current intensity from 20,000 amperes to 50,000 amperes, for example, it would only be necessary to change the voltage of supply to the condensers from 300 volts to 500 volts, the shape of the discharge curve remaining constant, the only variation being in intensity. The condition that the discharge shall not be oscillating is given by $R^2 = 4L/C$ where the value of R is of course in this case the primary resistance plus the secondary resistance referred to the primary. In practice it is easy to ensure that this condition is fulfilled and that a D.C. discharge is obtained. The shortest time of the discharge is when $R^2 = 4\ L/C$.

The transformer by which, through a rectifier, voltage is applied to the condensers is provided with tappings for adjusting the voltage and it is thus made possible to weld sheet metal of thicknesses varying from 24 to 12 S.W.G. solely by changing the tappings, the shape of the discharge curve remaining the same. It is, however, of practical importance to be able to alter the shape of the discharge curve in order, for instance, to avoid the metal projections which sometimes occur between the metal sheets. This is done by varying the ratio between R^2 and L/C by varying the capacity. This adjustment is made by selector switches and it is recommended to use one value of capacity for 24 and 22 S.W.G. sheets, a higher value for 20–16 S.W.G. sheets, and a higher value still for 14–12 S.W.G. sheets. At the same time the voltage is varied in proportion to the square root of the capacity used and in this way the best welding conditions are obtained.

The self-inductance of the machine depends partly on the throat dimensions and if they are altered it will be necessary to make a corresponding alteration somewhere else to keep the ratio L/C constant. This might be done by altering the capacity, but in practice it is more convenient to tap the transformer primary, and different throat lengths are then compensated by using different primary tappings. The correct tapping for each throat length is clearly marked on the machine.

The power required to charge the condenser depends mainly on the time that can be allowed. If a long time is permissible the actual power required is extremely small. At a recent demonstration 24 S.W.G. sheet was welded with a maximum current demand of 6 amperes at 110 volts or 660 watts. It

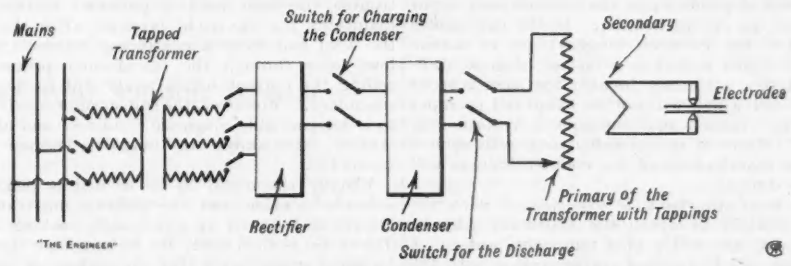


FIG. 1—WELDING MACHINE WITH CONDENSER STORAGE

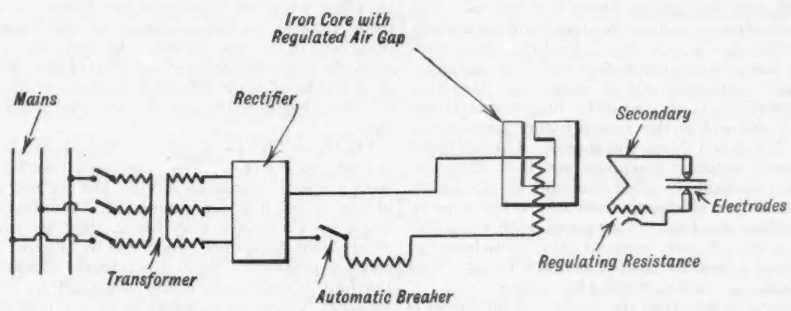


DIAGRAM OF MOTOR-CAR IGNITION SYSTEM.

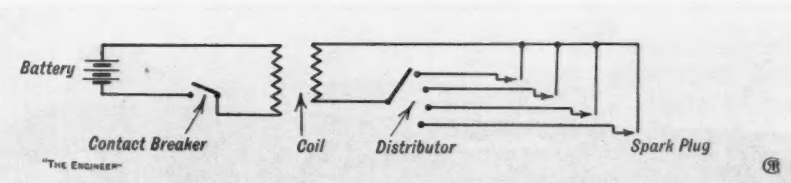


FIG. 2—WELDING MACHINE WITH INDUCTIVE STORAGE

is considered that for aircraft production a suitable charging time would be $\frac{3}{10}$ second which corresponds when welding 2 × 12 S.W.G. to a peak consumption of 25 kW. Charging takes place during the interval between each weld and does not limit the speed of welding in any way, except perhaps in the case of high speed stitch welding.

With induction machines the charging can only take start when the electrodes have closed on to the work piece and there is consequently always a waste of time. With these machines it is of course necessary that the current should be interrupted at a certain intensity corresponding with the energy stored $\frac{1}{2}$ LI². As the current may be increasing very rapidly, the chance of inaccuracy is considerable, particularly in view of the fact that the energy stored is proportional to the square of the current. Moreover, in machines of this type the proportion of the stored energy which is transferred to the secondary cannot be worked out exactly as it depends on the speed of operation of the contact breaker in the primary circuit. Since it can never be infinitely quick, some of the energy is always expended at the contacts of this breaker and any variation in the speed of operation leads to a variation in the amount of energy transferred to the weld.

The operation of this inductive system can be compared with that of a motor car coil ignition system as shown in Fig. 2 where, as is well known, a satisfactory spark depends upon the efficient and rapid operation of the circuit breaker. In the case under consideration the currents involved are of course very much higher and it is a matter of great difficulty to design a contact breaker for such current intensities and which will not be subjected to rapid wear of the contacts and consequent variation in operation. Hence it is inevitable that with such a system the maintenance of the contact breaker will prove very difficult.

But no such drawback is experienced with the condenser system in which the operation may be compared with the filling of a tank with water. A certain level will be reached corresponding with the pressure of the supply at which point the flow stops itself. The whole of the energy thus stored can be readily calculated and can be released without difficulty. Similarly the energy stored in the condensers is discharged into the welding transformer and thus supplied to the weld without any possibility of error.

The formulae for the discharge of condensers enable exact calculations of this energy to be made, but the formulae for inductive energy cannot be so readily applied because the energy delivered depends on the speed with which the current is interrupted; in other words, on the operation of the contact breaker, which cannot be predicted accurately and is unlikely to remain constant.

In the case of condenser storage welding machines, the maximum speed of welding depends on the time allowed for the charge, and thus on the allowable power that can be drawn from the mains. The charging period can, of course, be varied independently of the welding conditions. Philips Industrial (Licensees Languepin) condenser welding machines are generally equipped for a maximum speed of 30 spots per minute, but naturally higher speeds can be provided for and in this case a higher peak power would be demanded from the mains. Claims made for condenser welding machines are that they are more easily controlled, more constant in operation, and have a better efficiency than any other type of storage welding machine. Compared with induction machines they do not present the drawback of depending on a heavily loaded contact breaker and of the constant attention which this entails.

Apart from the fact that the surface of the metal is better after welding when the electrode pressure is high, it also depends on the material, shape, and condition of the electrodes. The best results appear to be obtained with electrodes containing a high percentage of copper. Philips Industrial electrodes have a special alloy called "Cuivrelect" which combines great hardness with good conductivity and is said to give excellent results. When welding light alloys particles of aluminium frequently stick to the electrode tip or particles of copper stick to the surface of the sheet. When this happens, rapid corrosion of the welded metal occurs and frequent cleaning of the electrodes is necessary. It has been noticed that the occurrence of these deposits depends on the electrode pressuring during the weld and the conclusion has been reached that great constancy of pressure is necessary, and to this end the inertia of the moving electrode on Philips' machines is kept down and rubbing action avoided. Moreover, with condenser machines a very high pressure can be used and the combined result is to prevent almost entirely deposit of metal on the electrodes and so reduce the cost of maintenance.

A further cause of the metal sticking to the electrodes is the self-inductance of the transformer and throat of the welding machine, causing a weak but not negligible current to flow when the electrodes separate. Sparking then damages the surface of the metal and electrode tip, but to overcome the trouble the firm used a patented method which maintains the electrode pressure after the end of the weld and sends a continuous reverse current of low value through the transformer primary, cancelling the current which tends still to flow in the secondary. Moreover, the transformer core is restored to a determinable magnetic condition and all irregularities attributable to magnetic remanence are prevented.

Usually the metal to be welded is pickled in a suitable solution and the pickling must, of course, always be followed by a thorough washing in water. The metal is then ready for welding, but this cannot be done immediately, for the surface of the metal should be protected against oxidation by a coating of light oil which should be wiped off before the welding is actually done. Alternatively to chemical pickling the metal can be cleaned mechanically by means of a rotary wire brush, but sand blasting should be avoided.

Care should be taken when setting up the machine to see that the electrodes are perfectly centred with one another and well polished. Moreover, the work should be offered absolutely square. Owing to a special device for holding the electrodes and the suppression of sparking when the movable electrode is withdrawn a Philips Industrial machine is claimed to be much easier to maintain than other machines. With clean metal and careful regulation frequent electrode cleaning is unnecessary. A light rubbing with emery cloth every 200 spots is quite sufficient.

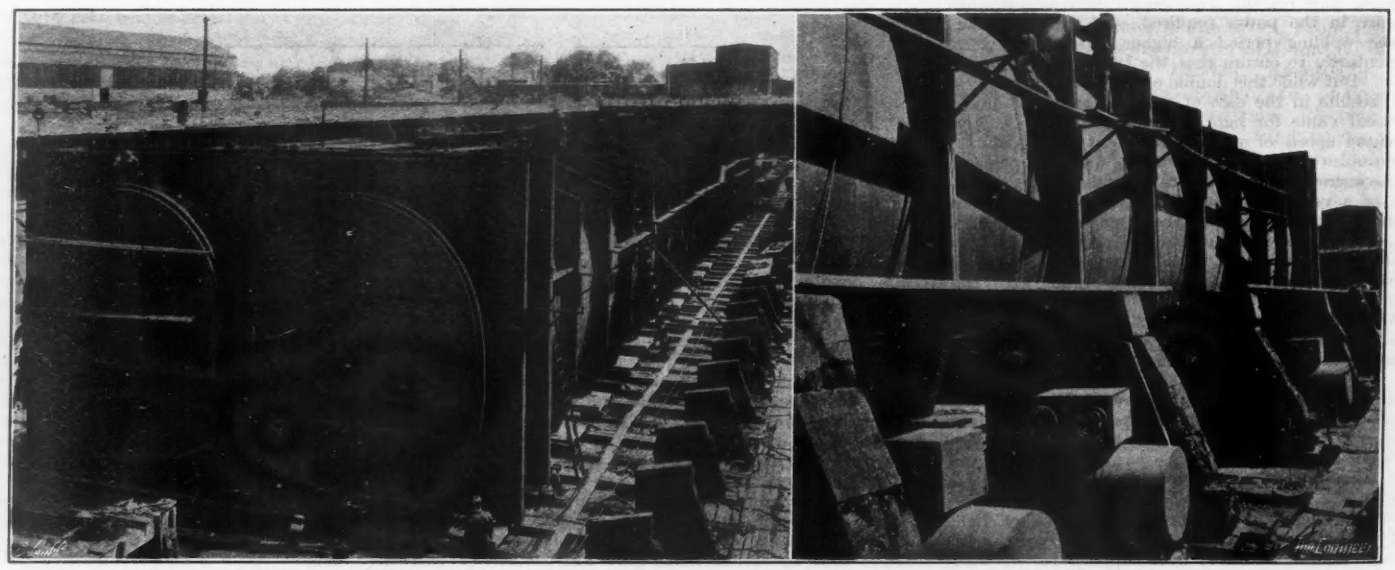
The dimensions of the electrodes given in tables supplied with the machines are based on the most usual practice in consideration of the thickness and composition of the metal. Actually it is possible with the same thickness of metal to obtain satisfactory spot welds of very different diameters provided the current is regulated to suit the diameter of the electrode tip.

On these Philips' machines, the electrode pressure is easy to control. The machines can be supplied with a double variation device, but for use with light alloys it is not recommended. Whatever advantages such a device may bring, they are outweighed where light alloys are concerned by the use of a high contact pressure. With a condenser storage welding machine economy in power obtained by the double pressure variation method is of no importance, as the heavy peak power used for each weld is not thrown back on the mains. Another disadvantage of the pressure variation system is that it calls for rather delicate handling, otherwise the welding may be very irregular. Nor must it be forgotten that with high constant pressure, projections do not occur between the work pieces and objectional picking of the electrodes is avoided. Tables supplied with the machines show the best pressures to use for various thicknesses of different alloys.

The conclusions reached from the foregoing considerations are as follows:—(1) Light alloys must be welded with high electrode pressures to obtain regularity and to avoid rapid deterioration of the electrodes; (2) the quantity of heat supplied to the weld must be very carefully controlled and this can only be done satisfactorily with an electronic interrupter or by an accurate and efficient storage device; (3) since the charge of storage condenser machines is limited automatically to a given value according to the peak voltage of the supply, they are very convenient in operation; (4) welding at very high speeds, *i.e.*, less than a hundredth of a second offers no advantage and can give rise to metal projections between the work pieces. On the other hand, an unduly long current time increases the power consumption and leads to distortion of the work; (5) the condenser method has the advantage that the discharge time can be controlled without the use of a resistance and thus without lessening the efficiency. The discharge curve can be made to extend over 1 to 5 cycles, and these times seem to be the most favourable.

Arc Welded River Tunnel for Chicago

CHICAGO'S new river tunnel, a double tube of steel, 200ft. long, 40ft. wide, and 23ft. high, which is to carry State Street subway cars under the Chicago river, will be ready for sinking into position this month. The steel work itself is virtually completed, and the work of adding a lining and outer layer of concrete is proceeding. The tube will be sunk into position in a trench dredged to a 30ft. depth below the river bottom. The 6500-ton double tube will be sealed at both ends, towed 15 miles to its site, and sunk by pouring concrete on its top. This steel tube structure is arc welded throughout by the shielded arc process of electric welding, accomplished with welding generators and electrodes supplied by the Lincoln Electric Company. An accompanying engraving gives a general view of the tube under construction in the dry dock by arc welding. In this illustration can be seen the two rectangular positioning bulkheads at either end and the intermediate framing stiffeners. Another engraving shows details of the arc welded construction. The thickness of steel in the tube wall is $\frac{5}{16}$in. Stiffeners, inside, are T-bars 3½in. × 4in. × ⅜in. on 4ft. centres. Holes are punched in the frame and stem of the T-bars on 18in. centres for the reinforcing rods for the concrete which is to be added. Stiffeners on the outside have ½in. web with angles 2½in. × $\frac{5}{16}$in. Following the welding, the tube will be given its inner and outer layer of concrete. The plan is to pour part of the concrete in the dry dock. The concrete inside wall will be 2ft. thick at the side and bottom, and an average thickness of 3ft. at the top. The tube will be towed from the dry dock into the lake and up the lake to the lock at the mouth of the Chicago River, through the mouth of the Chicago River to its position at State Street, where it will be sunk to the bottom. Steel cables operated from barges at each end will control the sinking. Following submersion, sand



ARC WELDED TUNNEL UNDER CONSTRUCTION IN DRY DOCK

and clay will be filled in to restore the river bottom. Each of the two ends of the tube will fit into a large cofferdam where connection with additional subway sections will be made in dry ground. Caissons on either side of the tunnel in the cofferdam will serve as supports for piers of the new State Street bridge to be built across the river at the site of the tunnel.

Long Distance Transmission*

LONG-DISTANCE transmission lines present difficult problems to the designer and the operating engineer. Lines of 300 miles in length are considered remarkable, and every time their construction has been undertaken engineering science has had to use the most elaborate methods and tools to achieve success.

Of the many problems encountered, probably the most interesting is that concerning the charging currents, as these become quite disproportionate on distances exceeding 150 miles. This is not generally realised by most engineers unfamiliar with long lines, and the following description of the operating procedure in a transmission line of this sort, showing the magnitude of the charging currents and complexity of the switching sequence, may be of interest.

The transmission system here described is that of the Pacific Gas and Electric Company, and links the hydro-development of Pit River in the Sierra Nevada to the load centre of the San Francisco Bay, this line being one of the many that interconnect the whole of California.

Although four generating stations are included in this system, the diagram has been simplified by showing only one, and omitting the 11-kV switchgear. At the power house, three 25-MVA alternators generate at 11 kV, which is stepped up to 220 kV for transmission. A receiving substation 200 miles away steps down this voltage to 110 kV for local

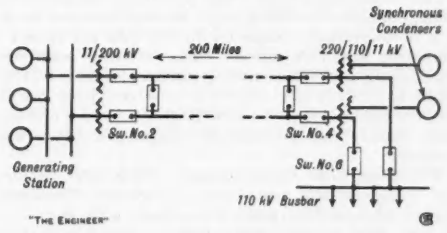


DIAGRAM OF TRANSMISSION SYSTEM

transmission. The transformers at the receiving substation possess an 11-kV tertiary winding, supplying two 40-MVAR synchronous condensers.

The purpose of these condensers, as it will be seen in what follows, is not only to regulate the voltage at the receiving end, which is their main object, but also to counteract the leading power factor of the line when connecting or disconnecting one of the two transmission lines running in parallel. The machines can be run from full lagging power factor (without excitation) to full leading power factor at maximum excitation, according to the requirements of the system. The voltage between changes is kept constant by means of wide range voltage regulators.

Sometimes at night, owing to light load and leading power factor, the voltage at the receiving end will rise over the allowable value, even with both synchronous condensers running at full lagging power factor. The only solution, should this happen, is to open one of the lines at each end, so as to decrease the static capacity and use only one line for transmission.

This operation is not simply a matter of opening the parallel h.t. switches and the line switches at each end of the required line. If this were done, a heavy disturbance would occur over a large part of the network, owing to the removal of the charging current, affecting millions of consumers, and producing the same effect as would occur under relay operation attributable to fault. To avoid this an elaborate technique has to be adopted, the operating procedure being as follows :—

The generating station drops the load on one generator, and connects it to the line which is to be switched out, using a free 11-kV bus-bar, the h.t. parallelling switches being opened at both ends. At that moment the receiving substation opens the 110-kV switch No. 6, thus leaving a synchronous condenser as the only load on that line. Its exciter switch has been opened, so it runs at full lagging power factor.

The opening of switch No. 6 separates from the main system the circuit formed by one generator at one end, and a synchronous condenser at the other. They constitute an independent system, the speed of which decreases as the machines run down to standstill rapidly. A volt-meter at the receiving end will show the voltage dropping at a rate corresponding to the drop in speed, until it becomes practically zero. At that moment the h.t. line switches No. 2 and No. 4 can be opened without causing any disturbance to the network. The whole operation will take about ten minutes. Following this, the synchronous condenser will be brought up to speed, synchronised, and connected to the main system again.

The " bringing in " or charging of the line necessitates the reverse operation. The magnitude of the charging currents will be better visualised by the fact that during one of these operations a 25-MVA generator tripped out overloaded by wattless current, although 23 lagging MVAR were supplied by a synchronous condenser at the receiving end. The rate of increase of excitation and load had to be readjusted until the machine charged the line and came up to synchronous speed in the normal way.

On one occasion, during an h.t. bushing pressure test, a synchronous condenser, properly excited and running by inertia, was used as a momentary generator. The bushing under test was at the far end of the transmission line, and it was found that owing to the capacitive load, the synchronous condenser came to a standstill in one minute. Normally, on open circuit, it would have revolved for nearly half an hour.

The 300-mile line from Boulder Dam to Los Angeles presents this problem even to a greater extent, although there the difficulties have been solved by having 85-MVA generators and two 60-MVAR synchronous condensers. The former can easily charge a line and the latter regulate the voltage over the range required. Moreover, the line has been sectionalised into three parts by means of two switching centres, with the view to increased stability.

* A paper by F. Zavala in the September issue of the I.E.E. Students' Journal.

Heat from Sulphur Dioxide

WITHIN the past decade, flash roasting of pyrite concentrates has replaced the burning of brimstone for the production of sulphide cooking acid in several of the Canadian newsprint paper plants. One of the outstanding installations is by the St. Lawrence Paper Mills Company, Ltd., at Three Rivers, Quebec. In this plant the sulphur dioxide gases given off from the pyrite roaster are cooled in a waste heat boiler before they are introduced into the scrubbing and absorption towers. The waste heat boiler performs four important functions :—

1. Cools sulphur dioxide gas from the temperature of combustion to a temperature suitable for the scrubber.
2. Prevents formation of undesirable trioxide by cooling the gases rapidly.
3. Furnishes steam at 115 lb. gauge pressure for cooking pulp in digesters.
4. Recovers heat otherwise lost in the process.

The pyrite is fed into a ball mill which breaks up any agglomerations formed in storage. The fine particles are then carried through a burner with a turbulent motion into the upper part of a Nichols-Freeman flash roaster. While slowly falling through the combustion chamber, the particles are oxidised, combustion being completed near the bottom, where they meet a rising draught of secondary air. The temperature in the combustion chamber is limited to just over 1000 deg. Cent. (1832 deg. Fah.) by recirculating a portion of the cooled SO_2 gas into the top of the chamber. For starting up after shut-downs, an oil burner is provided. The solid products of combustion, consisting of roasted ore, or calcine, fall to the bottom and are removed on a conveyor. This calcine, which is finely divided iron oxide, may be used for a variety of commercial applications. The sulphur dioxide (SO_2) gas is withdrawn from the top of the roaster and cooled below 400 deg. Cent. (750 deg. Fah.) before entering the water scrubbers. Between these two temperatures is the critical range for the formation of sulphur trioxide, and this is most undesirable, since it forms sulphates in the sulphide acid and may cause precipitation of calcium sulphate ($CaSO_4$) inside the equipment.

The formation of sulphur trioxide is almost entirely prevented if the temperature drop is very rapid. This rapid cooling is accomplished in a waste heat boiler that contains a series of steel tubes encased in smooth cast-iron rings and having a surface of 696 square feet. The tubes are arranged horizontally and are swept by the gases as they flow downward from the entrance at the top to the hopper at the bottom. The cast iron on the tubes presents a heat-absorbing surface that is considerably greater than that of bare steel tubes and offers almost perfect resistance to corrosive gases. Cast iron is also used on the return bends which are not in the direct path of the gases, but may be exposed to SO_2 gas during the blowing down of the boiler tubes. This is done once every eight hours with a compressed-air lance to free the tubes from any accumulations of dust that may be carried over from the combustion chamber with the gas. The dust is collected on the hopper at the bottom of the boiler and emptied into the conveyor. The sulphur dioxide gas, after being swept downward over the boiler tubes and cooled, is turned upward nearly at right angles and passed on through the scrubbing and cooling towers. A lead-lined gas fan provides the suction that draws the gases through the system from the combustion chamber and forces them out through two limestone absorption towers.

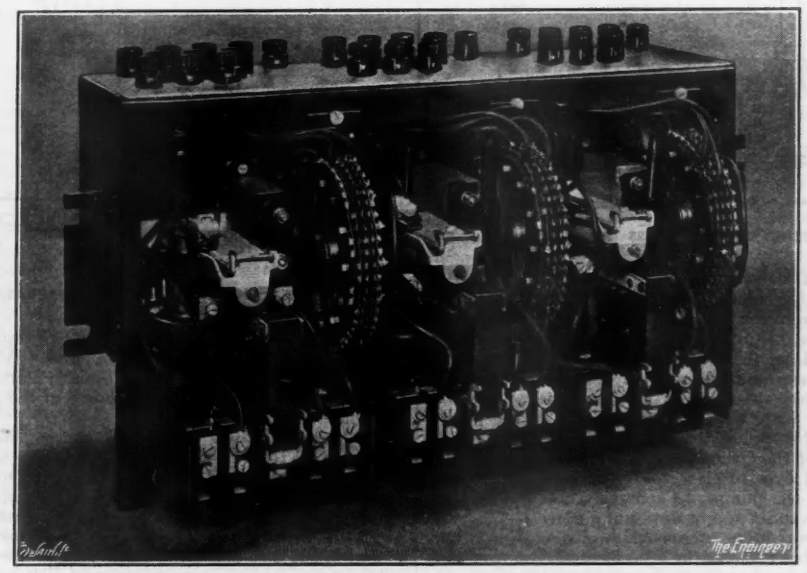
The boiler is expected to handle 11,000 lb. per hour of the SO_2 gas, based on the daily burning of 24 long tons of pyrite with 12 per cent. SO_2. Under these conditions the boiler will cool the gas from 1832 deg. to 650 deg. Fah. while generating 3260 lb. of saturated steam per hour at 115 lb. gauge pressure from feed water at 210 deg. Fah. The steam produced is used in pulp digesters.

Since 1933, when a waste heat boiler with cast-iron extended surface was installed at Three Rivers by the St. Lawrence Paper Mills Company, there has been no indication of corrosion of the tubes, and no shut-downs have been required for mechanical reasons. Very little sulphur trioxide is formed with the use of this system. The steam produced from and at 212 deg. Fah. per lb. of dry pyrite burned, amounted to 1·68 lb. in the month of October, 1938. This represents operation at about three-quarters capacity, and it is expected that the steam rate will be even higher when the unit is operated at full load.

Electrically Operated Soot Blowing Equipment

As the result of experience gained during the last four years in the operation of electrically driven soot blower equipments, the British Thomson-Houston Company, Ltd., has developed equipments which while in every way as reliable as the earlier equipments are less expensive. As the control is considerably more compact than it was originally, the floor space needed is roughly halved. Very little alteration to the actual blower heads is required. It is only necessary to fit a small limit switch to render the scheme suitable for any make of head. For the purpose of control the equipment consists of a master panel for all the heads and a control unit for each head.

The accompanying illustration shows the standard arrangement of three control units with the dust-tight cover removed and when it is stated that the dimensions of this control unit for the three heads are approximately 16in. by 9in. by 8in. and that the



CONTROL UNITS FOR SOOT BLOWING EQUIPMENT

master panel occupies about twice this space, the compactness of the arrangement will be realised. These triple units are arranged for mounting in racks, either in a special cubicle or in the cubicles of some other boiler house control.

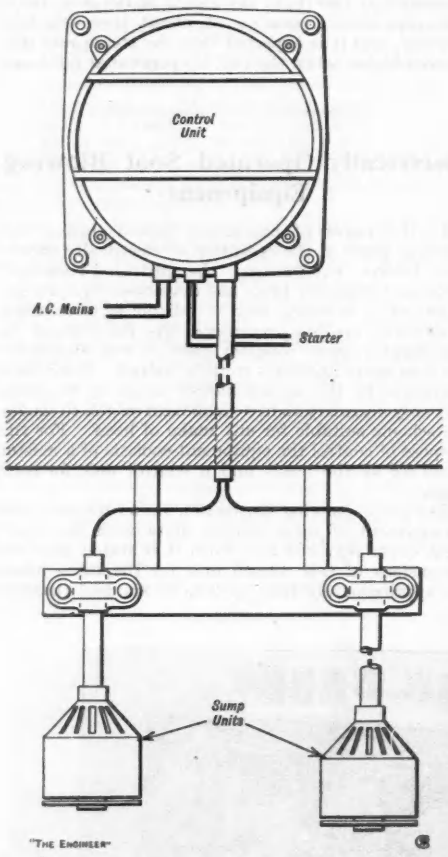
Each unit comprises a multi-contact solenoid operated switch. At each revolution of the head an impulse is given to the solenoid by the operation of the control switch so that the moving contact of the multi-contact switch is advanced a point at each revolution of the head. As the appropriate points are reached, the multi-contact switch makes changes in connections as required. The push button panels used in conjunction with the control give alternatively automatic sequencing of the heads or the blowing of heads individually. Provision is made for rendering the control of any individual head inoperative when desired either in sequence or individually. By changing the connections on the control unit, the number of blows given by each unit can be altered.

The contactor to be seen at the bottom of each unit is controlled by the multi-point switch, to connect the motor of the head to the line, the small relay to be seen above it being interposed to relieve the switch of the contactor coil current.

When the motor of the heads has to be reversed, the lines to which the motor is connected are reversed by reversing contactors on the master panel, and these contactors are controlled by the multi-contact switches. At the appropriate point the multi-contact switch gives an impulse to the next unit to start up the next head.

Floatless Pump Control

AN interesting system of automatic pump control, known as the "Antila," is now being made by Ralph E. Smart, Ltd., of India Works, Havelock Road, Southall, Middlesex. It is designed to work without the use of floats or other moving parts in the sump or well to be pumped out and is claimed to be quite unaffected by deposits of sludge or scale on the parts which come into contact with the water. In this equipment the control unit, which is connected to two or more sump units, may be situated at any distance from the sump.



ARRANGEMENT OF FLOATLESS PUMP CONTROL SET

The control unit has mercury switches which are interposed in the pump motor circuits and these switches are mounted on relays which tip them to open or close the circuit. Until energised the relays are held, with the switches tipped in the "off" position, by springs. When the relays are energised the pull of the springs is overcome and the switches are pulled over to close the motor contactor circuit and start the pumps. Each relay coil is connected by a cable to its appropriate sump unit.

The sump units each consist of a coil of rubber coated cable enclosed in a perforated cast iron case, suspended on a tube of the required length, in the sump. The tubes from which the units are suspended are clamped to an angle iron fixed to the side of the sump and the height of the units can be adjusted over a considerable distance. Each sump unit when immersed in water forms a condenser of a certain capacity which decreases when the water recedes. The relay coils in the control unit are energised as the capacity of the condenser increases and de-energised as it decreases.

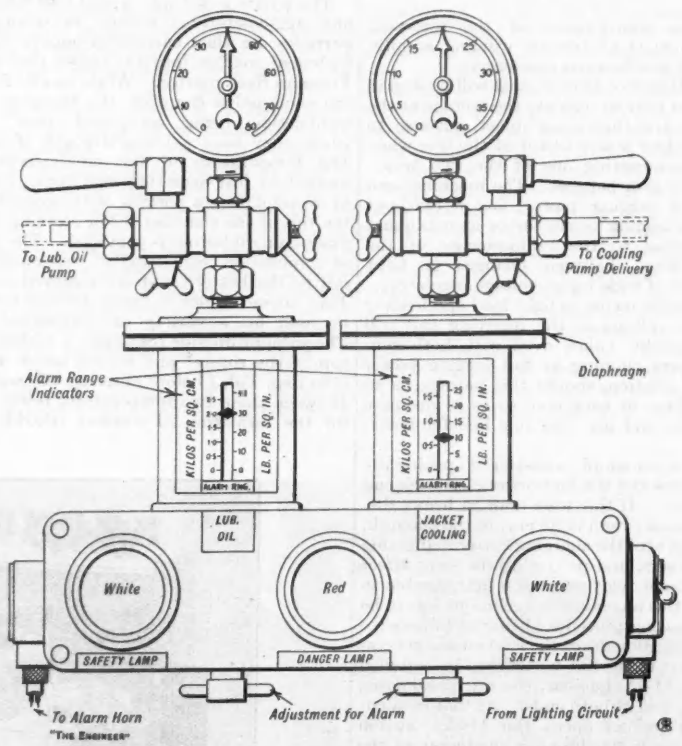
The method of operation may be explained with reference to the accompanying diagram which shows the arrangement for a set for controlling one pump, in which one relay and two sump units are used. One sump unit is fixed at the level to which water may rise without the necessity for pumping and the other at the level at which pumping must begin. As the water rises it first covers the lower unit which supplies only sufficient energy to hold the relay in, but not enough to pull it over and tip the switch to make the contactor circuit. On the water reaching the upper unit, sufficient energy is given by the two condensers together to pull the relay over and tip the switch to start the pump motor.

As pumping proceeds the level of the water drops below the upper unit and energy is taken from the relay coil. At this point, however, sufficient energy is maintained in the coil by the lower unit to hold the relay in and prevent the motor circuit being broken. When the water level falls below the second unit the remainder of the relay circuit is de-energised and it is pulled back by the spring to break the contactor circuit and stop the pump motor.

Where it is required to instal two pumps in a sump, three sump units are employed with two relays in the control unit. The sump units are arranged with one at the lower or pump stopping level, and the others at levels at which it is required to start the respective pumps. Such an installation may also include a switch for shutting down the duty pump should the stand-by pump start working, and also a change-over switch to bring either pump to first duty as required.

A New Pressure Alarm

IN order to avoid the usual practice of fitting separate pressure alarms in the cooling water and lubricating oil circuits of an oil engine a single unit, in which the two alarms have been assembled on a common indicator panel, is now being made by Monitor Patent Safety Devices, Ltd., of Kings Road, Wallsend-on-Tyne. It can be rapidly and easily fitted to an engine by simply connecting the cocks of the respective gauges to the oil and water pipes and leading a two-core cable from the lighting circuit to a junction box at one end of the panel. A second cable connects the panel with an electric alarm horn. The arrangement of the unit is shown in the accompanying engraving.



ARRANGEMENT OF PRESSURE ALARM FOR LUBRICATION AND WATER COOLING

The pressure gauge for the oil system shown is graduated up to 80 lb. per square inch, as the working pressure in starting up from cold may be much in excess of the working pressure. There is no electrical connection in the pressure gauges as the alarm works on the diaphragm principle, the electrical gear being housed in the case below the alarm range indicators.

The alarm-range is from 40 lb. per square inch to zero for the lubricating oil and 25 lb. per square inch to zero for the cooling water. The alarm is quickly adjusted for any pressure throughout its range by turning the handles at the bottom of the case to set the pointers for the alarm indicators below the gauge dials.

When the engine is running white safety lamps in the panel remain alight provided the pressures of the oil and cooling water are above danger point. Should the pressure in either system fall below safety the white lamp goes out and a red danger lamp lights up. At the same time the alarm horn will sound. The alarm can be stopped by opening a tumbler switch adjoining the junction box whereon all the lamps in the panel go out.

Cocks between the gauges and pipes are used for testing the alarms whilst the engine is running. When the alarm operates, the pressure on the gauge should correspond with the pointer of the alarm range indicator. This device is specially designed for oil engine driven generators on board ship, and also on account of the small space occupied is useful for the engine-rooms of small motor craft.

Pretoria Steel Works

THE South African Iron and Steel Industrial Corporation has recently entered upon extensive additions to the plant of its Pretoria Steel Works (Iscor) with the object of increasing the steel production by 100,000 tons a year, and full particulars of what is to be done have been furnished to THE ENGINEER by the management as follows:—A contract has recently been entered into by Iscor and the Woodall Duckham Company, Ltd., England, for the provision of a new battery of coke ovens and by-products plant. A considerable portion of the contract will be undertaken in the Union, and the plant is expected to be complete in less than eighteen months' time.

Coal Handling Plant.—The existing coal handling plant, capable of dealing with 90 long tons per hour, is to be increased in capacity to 120 tons per hour by increasing the belt speeds. The existing conveyor discharging into the existing service bunker will be made to deliver also on to a new conveyor which delivers the coal into the new 2000-ton service bunker. This bunker has a separate compartment for test purposes.

The New Coke Ovens Battery.—The new battery will comprise 45 top-charged Woodall Duckham Becker cross regenerative ovens each 40ft. 8in. long by 13ft. high by 16in. mean width. The new battery will be situated parallel to and at the back of the present plant.

The battery is designed for underfiring with blast furnace or coke oven gas, with a normal coking time of 16 hours when charged with 961 tons wet coal per day, the coal having the following approximate analysis:—

Volatile matter	... ...	33·5 per cent.
Fixed Carbon	... ...	55·0 per cent.
Ash	... ...	11·5 per cent.

and also having a moisture content of 8 per cent. when charged. The coke will be cooled by the wet quenching system. From the new 160ft. long coke

wharf the coke will be conveyed by means of 26in. conveyors to deliver on to the present conveyor leading from the existing coke screening plant to the blast furnace bins. Screening is to be done at the blast furnaces just before the coke is charged into the blast furnace.

The new chimney will be 300ft. high having an inside diameter at the top of 10ft.

Self-Sealing Oven Doors.—The oven doors will be of the Wolffe self-sealing type with a metal to metal sealing joint. The door linings will be of refractory concrete.

Reversing of the fuel gas is to be by means of a motor, or steam engine stand-by, operated reversing machine arranged for automatic control by means of a master clock through an electrical timing device with emergency push button control. The charging car of 15¾-ton capacity will be automatically weighed and each charge loaded and emptied by means of a 50-ton weighbridge.

The pusher machine is to be a combined coke pushing, coal levelling, door lifting, and extracting machine with each of the four motions operated by a separate motor. The ram will have a stroke of about 56ft.

Interesting features of this machine are a mechanically operated adjusting device for tightening the self-sealing doors, and a compressed air jet on the ram head for blowing off the oven roof, the jet being fed through a flexible pipe from a small compressor situated on the pusher machine.

The rest of the oven machinery all of which, with the exception of the electric locomotive, is to be of Buchanan manufacture, will comprise a combined coke guide and door extractor and a coke quenching car of 10 tons capacity. Mechanical door tightening is also to be provided on the coke guide machine. The electric locomotive for the coke car is being supplied by Robert Stephenson and Hawthorns, Ltd.

By-Products Plant.—The new by-product plant is designed for a peak maximum gas quantity of about 560,000 cubic feet per hour with a working normal throughput of 445,000 cubic feet per hour both measured at 60 deg. Fah. and 30in. Hg. and saturated.

A new suction main will deliver the gas from the new battery over the existing one, through three (one spare) vertical tube primary coolers to the exhauster house where a new exhauster, of the same type and capacity as the two existing ones, has been installed. Two exhausters will each separately handle the gases from the two batteries, but the mains will be so interconnected that one exhauster will act as standby for either battery.

The condensed tar and liquor flowing continuously via a downcomer from the suction main will be separated in an elevated hopper-bottomed separating tank from which the sludge will be delivered by pump to the coal handling plant.

The two gas streams from the two operating exhausters will pass separately through two electrical tar precipitators of the W.W.D. type, thereafter the gas from the existing plant will follow its present course. The existing P.A. tar extractors will act as stand-by for both plants. The gas from the new battery after leaving the electrical tar extractor will pass through three final coolers of the horizontal tube type; the cooled gas will then pass through Holmes static ammonia scrubbers which will reduce the ammonia content of the gas to below 2 grains per 100 cubic feet. After the ammonia scrubbers the gas will pass in series through two tower scrubbers whose surfaces will be lagged in order to eliminate the influence of high sun temperature.

The hot and cold condensates from the primary coolers will be separated and a certain portion of the hot condensates will be returned to a flushing tank in order to keep the cooling and flushing liquor level constant. The rest of the condensates together with the strong liquor from the ammonia scrubbers will be concentrated to a 25 per cent. liquor in a Wilton continuous concentrated ammonia liquor plant.

In the benzole house a new wash oil still will deal with the benzolised oil from the new plant. Two stage indirect water cooling will be adopted for the debenzolised wash oil for the new and the existing plants.

The new and the old wash oil stills will each be equipped with a fractionating column so that a high grade washable benzole will be continuously made. A new washer will also be provided.

One new 8300-gall. capacity final still with 20 trays, together with the existing intermediate still also equipped with 20 trays, will distil the washed product from the wash oil stills of both plants into close-cut fractions. The column on the existing final still will be extended to 30 trays and will be equipped with a new total condenser and a pump for reflux. This still will then produce nitration toluole and other close-cut solvents from suitable solvent crudes. A new water cooling frame of Foster Wheeler type having variable pitch fans, and a frame capacity of 162,000 gallons per hour, is included in the new contract.

Tar Plant.—Wilton's patent continuous type tar plant with pipe still will be installed to treat the whole of the tar production from the two batteries. The new tar plant will be capable of distilling 100 tons of crude tar per 24 hours when producing pitch of K. and S. melting point approximately 80 deg. C. and five well defined oil fractions. Road tar blending plant will also be included in the contract. The whole of the existing and new plants will form a very pleasing lay-out, and the arrangement is such that the minimum amount of labour will be required for efficient operation, and that large future extensions may be carried out.

Extension to Steel Melting Plant.—In accordance with the policy of increasing the production of Iscor Works the Corporation has placed a contract with Duncan Stewart and Co., Ltd., of Glasgow, for a Bessemer plant. This plant will operate in conjunction with the present open-hearth furnaces in the Duplex process and a considerable gain in production is planned.

The plant will comprise a 750-ton inactive mixer, two 25-ton acid converters, an electrically driven blower, bottom making plant, together with the auxiliary equipment, and additional buildings. Furthermore two additional 110-ton overhead cranes will be installed, one in the charging bay and one in the casting bay.

The mixer and the two converters will be housed in an extension of the present charging bay. The length of this extension is 172ft. The mixer will be under a roof, but the converters will stand in the open. An extension of 86ft. is being made to the casting bay. Provision is made for transport of metal from the converter bay to the casting bay by means of a transfer case. The bottom making plant and blower will be housed in separate buildings.

The mixer will have a capacity of 750 short tons, and be capable of being enlarged to 1000 short tons. It is to be electrically tilted and on normal operation a D.C. drive will be used. An A.C. drive is also to be provided in case of any failure of the D.C. The filling lid will be operated by an electric motor. Two heating nozzles will be supplied, one at each end of the vessel, and will be fired with coke oven gas. A special motor driven fan will supply combustion air to the nozzles. The lining will be of blast furnace quality fire-brick and the thickness will vary from 27in. to 25in. The speed of pouring will be 2in. per second.

25-ton Converters.—The converters will be of the eccentric type, with "Holley" type bottoms. The capacity will be 25 tons. The inside diameter of the vessels will be 10ft. 6in. and the depth of bath 19in. to 20in. The thickness of lining will be 15in. The depth of lining of the bottom will be 33in. and there will be 30 tuyeres each with 7 holes of §in. diameter. The converters will be acid lined and at first it is proposed to use silica brick. Later it is hoped that natural refractories such as firestone or mica schist of suitable quality will be found. The tilting will be electric. Two D.C. motors working together will be used, but they will be of such horse power that one of them could tilt the converter in case of emergency. The maximum tilting speed will be 90 deg. in seven seconds. Burners of a swivel type will be provided for drying out the vessels and for keeping them warm during idle periods.

The bottom repair plant will comprise a continuous coke oven gas fired drying oven designed to accommodate four bottoms and will give an output of nine bottoms per week. This plant will be housed in a separate building, which will be provided with bins for raw material, and will be serviced by a 30-ton overhead crane. Further an hydraulic jack-car for removing and replacing bottoms in the converter will be provided. The total lifting power of this car will be 75 tons. The car will be moved by a fireless locomotive, which at present is being used at the works.

Other auxiliary plant will be: A ladle weighbridge capable of weighing up to 110 short tons, two ladle drying burners designed for coke oven gas, and seven hot metal ladles.

Centrifugal Type Blower.—The blower will be a five-stage single flow machine of the centrifugal type, driven through gearing by means of a synchronous motor. It will, therefore, be a constant speed machine and the volume and pressure regulation required for Bessemer converter operation will be obtained by means of throttle and moveable vane control. The maximum volume of free air blown per minute will be approximately 34,000 cubic feet. The maximum pressure will be 35 lb. per square inch, although normally the set would deliver at about 30 lb. per square inch. The blower and its auxiliaries will be housed in a separate building, and the control will be arranged in such a manner that the machine can be started, stopped, and the conditions of pressure and volume altered by remote control push buttons in the converter pulpit.

The cranes will have main hoists of 110 tons with auxiliaries of 20 and 5 tons. These two auxiliary hoists are to be arranged on a separate cross traversing crab running inside the main crane girders. These two cranes will run on the 440 volt D.C. supply in line with the existing cranes. Roller bearings will be provided except on the long travel wheels.

The cranes will be supplied by Sir William Arrol and Co., Ltd., of Glasgow, and the blower by the Brown Boveri Company of Switzerland. The buildings will be erected by Dorman Long (Africa), Ltd., of Germiston. An appreciable portion of the contract will be executed in South Africa and local material will be used wherever possible. The time of completion will be about seventeen months.

Existing steelworks in South Africa can only supply about one-third of the country's total steel requirements and while these extensions of Iscor's output will help, South Africa will still be dependent upon overseas sources for the bulk of its steel requirements until something can be done on a bigger scale to increase steel production and to extend the range of steel products manufactured in South Africa. This aspect has been engaging attention, but it has been necessary to postpone further consideration of the matter until the effect of war conditions can be more clearly gauged, particularly in respect of plant deliveries and of prices.

The Iscor directorate has decided to proceed with the erection at Iscor Works of an up-to-date wire works for the production of all commercial grades of steel wire. Investigations as to the plant to be installed and the planning of the works are in progress, but war conditions may determine when a start can be made with construction work.

During the year ending June 30th, 1939, the production of steel ingots at the Iscor Works totalled 344,267 tons, an increase of over 12,000 tons compared with the preceding year. In the case of the sheet works production of sheets and light plates increased from 49,544 tons in 1937–38 to 57,612 tons during the year ended June last. Taking the main business, viz., rolled steel products, the total despatches from Iscor Works during 1938–39 amounted to 261,834 tons. The development in sales of rolled steel products during the last few years is reflected in the following figures:—Year ending, June 30th, 1935, 178,171 tons; 1937, 234,018 tons; 1939, 261,834 tons. For the year ended June 30th, 1936, Iscor's manufacturing profit was £435,665; for 1937, £669,279; for 1938, £1,236,122, and for 1939, £1,189,434. Out of the profits for 1939 an amount of £20,758, representing expenditure on mining development incurred prior to the starting up of Iscor Works was written off, provision for additions and improvement was made to the extent of £203,759, £400,000 was placed to general reserve, and dividends declared on "A" and "B" shares absorbed £360,000, making 6 per cent. for the year.

BRITISH STANDARDS INSTITUTION

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria Street, London, S.W.1. The price of each specification is 2s. 2d. post free, unless otherwise stated.

LIGHTING OF AIR RAID SHELTERS AND REPORT AND CONTROL CENTRES

(BS/ARP 6, 7, and 17).—The most important feature of the revised edition of BS/ARP 6, Lighting of Shelters for up to 200 persons, is the addition of a section detailing the equipment to be provided in cases where D.C. mains are available. The original issue of the specification appeared to have been drawn up with A.C. mains only in view, with the result that numerous queries arose as to what should be done in areas where the mains supply was D.C. This anomaly has now been removed. The specification for the lighting of large shelters (BS/ARP 17) is based on the principle that whereas in small shelters a battery installation is satisfactory as a stand-by, in large shelters a self-contained generator unit is advisable. The specification gives full details of the generator and battery-charging equipment, together with particulars of the number of lamps and their wattage.

Specification BS/ARP 7 gives the general requirements for the lighting of report centres, control centres, and the accommodation associated therewith. In these centres—the nerve centres of the whole A.R.P. organisation during an air raid—it is of course essential that an adequate amount of lighting be maintained under all conditions. The specification therefore defines what is regarded as an adequate amount of lighting, and gives details of the necessary equipment for lighting under emergency conditions. For normal lighting the supply is taken from the mains at the full mains voltage. The emergency lighting, which is brought into operation by means of a manually operated switch when the main supply fails, is provided by an entirely separate wiring system, the supply for which is at 24 volts and is obtained from an internal-combustion engine-driven generator. The emergency supply from the generator is supplemented by a battery capable of running the lights for short periods (for example, whilst the generating set is being started or maintenance or repair work is being carried out on it). The battery is intended to be brought into use immediately the main supply fails, and to be switched out of circuit as soon as the generating set can be brought into operation. Provision is made for charging the battery from the generator. It will be necessary to run the generator occasionally to keep the battery fully charged, and in this way the generator unit is maintained in good condition so as to be ready for immediate use in an emergency. The size of battery specified is such that the emergency lighting can, if necessary, operate from the battery for a period of 4 hours. The main ventilating plant is normally driven electrically from the supply mains. Under emergency conditions it is driven by mechanical coupling to the generator unit. The ventilating plant and generating set should, therefore, be installed in the same room. When under emergency conditions the lighting is run from the battery the ventilating plant should be manually operated. In addition to the main ventilating plant, provision is made for a small fan in each room where several persons are working.

Copies of these specifications may be obtained from the British Standards Institution, 28, Victoria Street, London, S.W.1, at the following prices:—BS/ARP 6, 6d. each, 8d. post free. BS/ARP 7, 6d. each, 8d. post free. BS/ARP 17, 1s. each, 1s. 2d. post free.

Markets, Notes and News

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quantities are f.o.b. steamer.

Machining Imports : A Warning

Cases have come to the notice of the Import Licensing Department of the Board of Trade in which importers have placed orders for machinery, plant, and appliances to be constructed abroad without first ascertaining that a licence for the importation of the goods will be issued. Importers are accordingly warned that no goods of this class can now be imported without a licence unless they are consigned directly to a Government Department, and the fact that an order has already been placed will not influence the Department in the direction of granting a licence which they would otherwise refuse. Accordingly, importers are advised not to place any orders abroad for machinery, plant, or appliances until they have either obtained an import licence or ascertained definitely that a licence will be granted or that no licence is required. Where it is expected that some considerable time will elapse between the placing of the order and the delivery of the goods, arrangements can be made, if necessary, to extend the period of validity of any licence that may be issued beyond the usual period of three months.

January Exports

The Board of Trade Returns in their summarised form show that the total exports during January reached in value £41,073,574, an increase of £1,593,976 on the total for January, 1939. The exports of coal last month were valued at £3,472,012, a gain on the corresponding month of 1939 of £579,675. Exports of iron ore and scrap in January were worth only £7099, which is a drop when compared with the first month of 1939 of £68,654. Non-ferrous metalliferous ores and scrap were exported to the value of £39,092, a decline of £148,848 compared with the figures for January, 1939. The exports of iron and steel and manufactures thereof were valued at £2,918,497, which shows an increase of £310,232 on the total for January last year. Exports of non-ferrous metals and manufactures thereof reached in value £1,213,793, this being a decrease of £60,961 when compared with the corresponding month of last year. Cutlery, hardware, implements, and instruments were exported to the value of £914,190, a rise over the figure of January, 1939, of £239,728. The exports of electrical goods and apparatus last month were valued at £1,213,752, which also showed a gain on the figure for January, 1939, of £118,873. The value of machinery exported amounted to £3,837,158 which was £731,018 less than January last year. The value of vehicles, including locomotives, ships, and aircraft sent overseas totalled £2,824,106, a drop of £1,762,575 when compared with January, 1939.

Imports in January

The total value of imports into Great Britain in January, according to the Board of Trade Returns, was £104,961,147, an increase of £29,389,330 over the value of the imports in January, 1939. Imports of iron ore and scrap last month were valued at £903,832, an increase over the figure for January 1939, of £510,810. Non-ferrous metalliferous ores and scrap were imported to the value of £3,054,596, a substantial increase of £1,638,652 upon the value for the corresponding month of 1939. The imports of iron and steel and manufactures thereof reached a total value of £1,582,983, which was £727,610 higher than the similar imports in January last year. Non-ferrous metals and manufactures thereof were imported to the value of £3,959,364, a rise on the figure for the same month last year of £942,052. The imports of cutlery, hardware, implements, and instruments were valued at £490,659 in January, a rise of £8663 on the January, 1939, figure. Electrical goods and apparatus imported last month reached in value £494,175, a rise of £268,118 on the figure for the corresponding month of 1939. Imports of machinery rose to £2,512,145 in January, an increase when compared with the same month last year of £674,524, whilst vehicles, including locomotives, ships, and aircraft were imported to the value of £461,368, or £12,330 above the value of the imports in January, 1939.

The Pig Iron Market

The position in the pig iron market has not deteriorated, but there is no apparent easing in the stringency which exists in some departments. In spite of the increase in the production of basic iron it does not seem to be more than sufficient to maintain the current rate of output; in fact it is only by a system of careful rationing that the industry is so adequately supplied. Pressure varies in the different departments. There is a strong demand for hematite, which is just now covered by the production, but in the case of this iron there are still stocks in makers' yards which can be drawn upon. Less stringent conditions prevail in the foundry department and a heavier demand for high phosphoric iron could be met if necessary. Supplies of low phosphoric iron, however, are tight. In the Cleveland district consumers of foundry iron rely almost entirely upon supplies of Midland irons and have done so for so long that they are now quite accustomed to the use of these descriptions. Some transport difficulties were experienced in January, but the effect of these is being rapidly overcome. Licences are difficult to obtain for iron for stock but firms are finding no difficulty in securing their current requirements. In the Midland market the demand for low phosphoric iron appears to be growing and although some attempt has been made to increase the production it is barely enough to meet requirements and hematite is used by many consumers as a substitute. Business in high phosphoric iron is irregular and represents the uncertain conditions in the light castings trade which, of course, is suffering from the decline in building operations. There is, however, a gradual increase in the number of these foundries which are turning over to Government work so that there are good prospects of a better demand for this class of iron. The output of the Scottish blast furnaces has been maintained and owing to their geographical position supplies of ore have not been greatly interfered with by climatic conditions. The makers are concentrating principally upon the production of basic and hematite iron, all of which is moving rapidly into consumption. The demand for foundry iron in Scotland is irregular as few of the light castings foundries are working at anything like capacity. There is a good demand for forge qualities in all districts, which seems to be expanding. In the Lancashire market conditions as regards pig iron are steady: business is active and supplies are reaching the works with satisfactory regularity.

Scotland and the North

The production of the Scottish steelworks has returned to the high level which has been maintained during the war with the exception of a period in January when the delivery of supplies was hampered by weather conditions. With the better supply position deliveries from the steelworks have also improved, but so heavy is the demand that it is doubtful if the capacity of the works is sufficient fully to meet it. Although new business has been rather quiet of late it is only because the works are so well booked that they cannot see their way to accept fresh orders until their books are less congested. Consumers, therefore, are searching the market to find firms in a position to accept business, and this is by no means easy. The production of joists and sections is at a particularly high level and a feature of the position is the rapidity with which the material is absorbed by the consuming industries. Large quantities are passing to the structural engineers who, in spite of some seasonal slackness, are busily occupied upon Government contracts. A number of important jobs are in hand and until they are completed there is no likelihood of any relaxation in the pressure upon the steel-makers for supplies. Hardly less vigorous is the call for steel from the shipbuilding industry, which has an enormous amount of work to deal with. Whilst it taxes the resources of the works to keep the consuming industries supplied, the Control is exerting every effort to maintain an equitable distribution of material. The call for plates is one of the features of the situation and the works producing this class of material are operating at as near to capacity as circumstances will allow. Extended delivery only is quoted for heavy and medium plates, and not only are the requirements of the shipyards large, but the locomotive makers, wagon builders and boiler makers are all well supplied with important contracts needing large tonnages of steel. The re-rolling industry is still suffering from a stringency in the supply of billets, which however is being partially relieved by imported material, and it is expected that supplies from the Continent will increase considerably in the near future. The re-rolling works have sufficient orders in hand to keep them occupied for months. Conditions in the Lancashire market are similar to those ruling in other districts. The structural engineers continue to take up large quantities of steel, whilst the boiler and tank makers are busy. The wire trades are also actively engaged. The engineering concerns, most of which are employed upon Government orders, are taking good supplies of special and alloy steels.

The North East Coast and Yorkshire

A high rate of production is maintained by the steelworks on the north east coast, but the demand continues to expand and there is a tendency for works deliveries to fall into arrears. Great pressure is being exercised by consumers to obtain supplies of structural steel in all forms and sizes. The demands of the constructional engineers now probably exceed any level previously reached, and it is not expected that there will be any decline in the volume of this business for a long time since they have a number of important contracts in hand and other schemes are likely to be initiated before or when these are completed. After the constructional engineers the shipyards are probably the largest consumers of steel. Without exception they are fully employed, and their demands for plates and sections taxes the resources of the producers. There is some stringency in the supplies of billets, although the British production is being pressed to the utmost. The severe January weather prevented supplies reaching some of the re-rolling works and this has caused unavoidable delays in deliveries. It is probable, however, that increased tonnages will be reaching this country soon from abroad, and now that transport has become more normal the arrears should be rapidly overtaken. A certain amount of export business has been transacted at the new quotations, but this can only be done by the Control allocating a certain amount of steel to the export trade. Many works are unable to quote for overseas business owing to the congestion of home trade contracts on their books and when an order is taken it is usually for far forward and indefinite delivery. No relief has been experienced by the steelmakers in the Yorkshire district from the insistent pressure of consumers to obtain deliveries. The production of basic steel is being forced to the utmost, but is insufficient to meet the expanding requirements of users. The demand for acid carbon steels has also broadened considerably during the past month or two, and the producing works are operating practically at capacity. The demand for billets in spite of the efforts of the works to increase output has fallen short of the needs of the market, but some relief may be experienced in this direction as a result of imports from abroad. The demand for alloy and tool steel is active and although production is at a high level it is not more than sufficient to meet the requirements of the consuming trades, chief amongst which are the engineering establishments.

Copper and Tin

Although there are indications that the war requirements of the Allies are not so large as during the last war, they are sufficiently extensive to absorb practically all the copper reaching this country, with the result that there is little for commercial work. Since nearly the whole of the output of manufactured copper is needed by the Government this has little influence upon the position, although of course it creates a certain amount of inconvenience in those trades which are not employed upon work of national importance. Now and again, however, small quantities are released for making materials for export. In the world market the price was slightly advanced to between 11·37c. and 11·62c. The American producers are well sold and although new business in the United States is distinctly quiet, the general view is that any renewal of buying would be rapidly reflected in an increase in quotations. Buying by neutral countries for commercial purposes has declined during the past few weeks, but neutral Governments appear to be taking fair quantities, probably for armament purposes. Scandinavian countries and Japan have been the principal buyers. According to reports received in London, the Australian Commonwealth Price Commissioner has raised the maximum price of copper to £76 after an investigation into the position. It is stated that an understanding has been reached that the difference between £72 and the new fixed price will be set aside for development and extension. This movement should not influence the position in this country, since it is understood that the Australian copper production is required for home needs. The United States copper statistics give the American production in January as 89,861 short tons, compared with 69,170 tons in January, 1939. The output of refined copper was 91,428 tons, compared with 66,316 tons last year. At the end of January the stocks of refined copper totalled 135,441 short tons, against 159,485 tons at the end of December, and 301,244 tons at the end of January, 1939. . . . Rather more active conditions have ruled in the tin market recently and prices have shown a tendency to advance. The market is chiefly interested in the result of the forthcoming meeting of the International Tin Committee, and it is expected that the quota will be reduced to 100 per cent. from the present 120 per cent. Some support is given to this belief by the reluctance of the Straits companies to sell in large quantities. On the other hand some doubt is expressed as to whether the authorities will permit the quota to be reduced although at present there is certainly no scarcity of tin.

Lead and Spelter

It is difficult to describe conditions in the lead market since whilst the London Metal Exchange is closed and no statistics are available the chief factors which go to make a market are unknown. The position, however, would appear to be satisfactory since there is no shortage of the metal although certain brands are at times difficult to obtain. The Control, however, appears to be able to provide adequate supplies for all firms engaged upon war work. Outside this country the demand for lead, after the initial impetus given to it by the war and the apparent expectation in neutral countries that a shortage would develop, now appears to be dwindling. In Mexico it is reported that stocks are increasing and the Mexican producers are understood to be willing to entertain comparatively low prices. The world requirements for commercial purposes are overshadowed by the demand for armament programmes which have been undertaken by several of the neutrals. In the United States the market has become easier, but the producers appear to have a large number of orders on their books yet to be completed. . . . The situation in the spelter market is similar to that in lead and with the Control as the only importer and distributor it is difficult to appraise the position. There is, however, plenty of evidence that the distribution of the metal is satisfactory and that there is no likelihood of a shortage. It would thus appear that the quantities of spelter reaching this country from Empire sources is adequate for the wartime effort, and that the misgivings entertained at the outbreak of hostilities that further quantities would have to be obtained were unfounded. A certain amount of spelter has been imported from Belgium since the war commenced, but lately there have apparently been no offers from that country. It is generally assumed that the Belgian home trade demand is absorbing the production which has decreased under war conditions, and that most of the metal is needed by the Belgian Government for munitions purposes. In the United States the demand has slackened considerably. Most consumers appear to have covered their requirements for some time, but on the other hand producers are not pressing sales and are reported to be well sold.

Non-Ferrous Metal Sales

A Direction has been issued entitled "The Control of Non-Ferrous Metals (No. 5) Order, 1939, Direction No. 2. Dated February 12th, 1940." In this Direction prices are fixed for small quantities of copper, lead, and zinc. For quantities of not more than 1 ton an addition to the maximum price of £4 per ton is permitted on copper, and £2 per ton on lead and zinc; for more than 1 ton, but not more than 2 tons, the addition is £3 in the case of copper, and £1 10s. for lead and zinc; whilst for more than 2 tons but less than 4 tons, the extra on copper is £2 and on lead and zinc £1 per ton.

INDIAN RAILWAY BUDGET.—When the Indian Railway Budget was presented recently, surpluses of Rs. 361 lakhs for 1939–40 and Rs. 829 lakhs for 1940–41 were announced.

French Engineering Notes

(From our own Correspondent in Paris)

Standardising Machine Tools

So considerable have been the imports of machine tools for armament work under unfavourable conditions of transport and financial sacrifice that the home production has assumed far greater importance than ever before. Preparations had long been made by the machine tool industry to meet this contingency. It was developed as a key industry under conditions that led the Chambre Syndicale of machine tool makers to adopt a policy that aimed primarily at monopolising the home market. The production was to be standardised with the object of simplifying manufacture and lowering production costs, and complete statistics were to be obtained of the number and types of machines employed in France so that makers could settle upon the quantities of each type that could be manufactured. It was proposed to offer advantages to users to renew their machines at the end of a stated period, and it was hoped in this way to enable machine tool makers to carry on a regular long-term programme of construction. To a large extent these statistics of the number and nature of the machine tools in use have already been collected as part of the organisation of armament work. Before armament production had entered upon an active phase the State had laid down conditions under which makers were to supply machine tools to the arsenals and Government factories. They were required to adopt a method of standardisation as a means of reducing costs, and the Government was to control these costs in order to check prices quoted to the State departments. The Government would not pay more for French than for imported machines. Makers demurred at a control of cost prices, which, however, is exercised during the war as a matter of course, but standardisation was in keeping with their own plans, an the norms formulated by the Comité de Normalisation de la Mécanique have been adopted for several types of machine tools. In order to hasten a complete standardisation of all metal working machine tools required by the Government, machines constructed to official norms are now exempted from the production tax. As all machine tool makers are working to their full capacity for the State this offer of fiscal relief may be expected to implant standardisation more firmly in this branch of industry.

Public Works Machinery

One of the problems to be dealt with when nations settle down again to peaceful operations will be the widening of opportunities for reciprocal trading in a manner to permit of increasing international exchanges. So far as mechanical engineering is concerned, these opportunities for trading between industrial countries have become more restricted as each country develops its own industrial production. By taking stock of each branch of the mechanical engineering industry it may be possible to form some idea of what the situation is likely to be when countries discuss this question of exchanges. One instance of the growth of a new branch of industry is afforded by the production of public works machinery which, less than ten years ago, was nearly all imported. When the economic crisis set in and a vast scheme of public relief works was put in hand, including the reconstruction of roads, there was a demand for road-making machinery that appeared likely to continue for several years. As the use of French machinery was associated with this problem of unemployment relief, a number of firms embarked upon the construction of road-making machines and constituted an association that laid a permanent foundation for the new industry. There are about 40 firms manufacturing materials for road making, and one half of them are machinery makers belonging to the association. Jules Weitz, of Lyons, and the Ateliers de la Rhonelle are specialists in road-making machinery. There are a dozen makers of road rollers and four of excavators and mechanical shovels. The industry is new and well organised and has developed rapidly from light to heavier duty machines without adhering too closely to foreign types. There is an obvious desire to introduce new ideas in construction that may be regarded as improvements on conventional designs. Considering what has been done during a very short period in the construction of big-capacity machines, apart from those manufactured under foreign licence, the industry will certainly develop rapidly in the future if justified by the home demand, for there is always capital for industrial expansion when conditions are favourable, and French makers will be able to supply most, if not all, of the public works machinery that may be required. Nevertheless, the future of the industry depends on the preferences of public works contractors, who look primarily to the economy in time and money which is necessarily associated with mechanical efficiency. In the great variety of road making machinery there is a wide field for competition, and for some work foreign machines have proved to be more efficient than the French. If only in the interests of public works contractors, who must take advantage of every means of effecting economies, competition should be left open, and there is therefore no reason to suppose that reciprocal arrangements after the war will exclude the importation of public works machinery.

Lighting Railway Trains

The method employed to obscure lights in railway coaches is to use blue electric lamp bulbs sufficiently deep in colour to make the inside of a compartment just discernable. The blinds have to be drawn down, and at first passengers were careful to see that this was done, but familiarity with possible risks that did not seem imminent left passengers negligent in taking this precaution. The National Railway Company has been making experiments with the better lighting of coaches, and the only solution found practicable is to enclose the lamp in a blue shade, the lower part of which has an orange coloured filter that diffuses the light downwards without directly reaching the windows. Reflection on the windows must be avoided by drawing down the blinds. The device has been tested out on one of the Paris suburban lines and is found quite satisfactory in providing a suitable light for reading and in avoiding any external luminous trace of the coaches if passengers will submit to the discipline of always keeping the blinds drawn.

British Patent Specifications

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

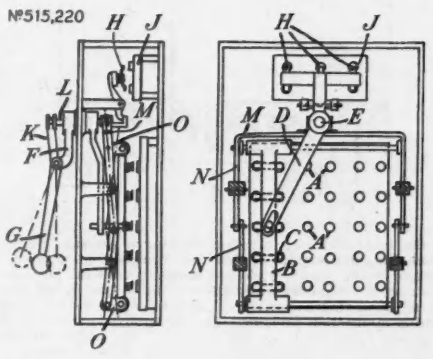
Copies of Specifications may be obtained at the Patent Office Sales Branch, 25, Southampton Buildings, Chancery Lane, W.C.2, 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

SWITCHGEAR

515,220. May 25th, 1938.—MULTI-POSITION ELECTRIC SWITCHES PARTICULARLY FOR CONTROLLING ELECTRIC MOTORS, the British Thomson-Houston Company, Ltd., Crown House, Aldwych, London, W.C.2, and William Leonard Wise, of 7, St. Alban's Road, Moseley, Birmingham.

This specification describes a multi-position electric switch used to connect the windings of an induction motor to the supply line in such alternative methods of connection as are necessary for the motor to run at a multiplicity of speeds. On a base of insulating material are mounted fixed contacts A in groups arranged in parallel lines. An insulated contact carrier B is adapted to be moved across the lines so that the moving contacts C bridge two groups of contacts A. The contact carrier B is operated by means of a link D secured to an operating shaft E to which is also secured a lever F on the outer end of which the operating handle G is pivoted so that it is capable also of move-



ment in a second plane, namely toward and away from the cover of the switch. In the example shown a movement of the lever G away from the switch will cause the contacts C to engage the contacts A and a movement of the lever toward the switch will cause the contacts to separate. A further movement of the handle toward the switch will cause the contacts H of an auxiliary switch J to close such as for establishing connections for a reversed rotation of a motor. Movement is transmitted to the moving contacts from the handle or lever C by means of a lever K secured to or formed integrally with lever G engaging a sliding spindle L, passing axially through levers F and D which operates a lever M acting on a toggle mechanism consisting of levers N and O which operate the carrier B. Suitable means may be provided for latching or releasing the carrier in or out of the contacting position and for latching the operating lever in either of the selector positions.—*November 29th*, 1939.

ELECTRICAL APPLIANCES

515,718. June 10th, 1938.—METHODS OF PROTECTING METALLIC ELECTRIC CONDUCTORS FROM CHEMICAL ATTACK AT HIGH OPERATING TEMPERATURES, the British Thomson-Houston Company, Ltd., Crown House, Aldwych, London, W.C.2, Leonard John Davies, 210, Hillmorton Road, and William Thomas Cowhig, 17, Bowen Road, both of Rugby.

This invention relates to methods of protecting metallic electric conductors, more particularly thin filaments, so that they may be operated at high temperatures when surrounded by chemically active liquids or gases. The filament is introduced into a quartz tube and the tube is then connected to an exhaust pump and evacuated. The tube is then progressively melted from one end on to the filament in such a manner that the quartz sinks at every point on to the filament making intimate contact therewith. Electrical connections can be made to the filament either by allowing the filament to project from the ends of the tube or preferably by connecting to it a strip of molybdenum and forming the well known molybdenum foil seal. It is necessary that the material of which the filament is made and the size of the filament should be such that the quartz does not crack either at normal temperature or at any elevated temperature to which the device may be raised in operation. It has been found that a suitable material is a tungsten wire of about 2 mil. diameter, and the wire may be straight or a spiralled wire similar to that used in incandescent lamps. As the quartz is in intimate contact with the filament, the filament cannot volatilise at high temperatures nor can it be affected by any liquid or gaseous chemical in which it is operated. —*December 12th*, 1939.

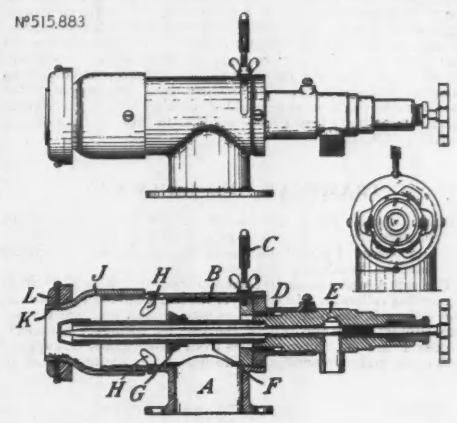
515,890. June 14th, 1938.—IMPROVEMENTS IN ELECTRICALLY INSULATING BODIES, A. Reyrolle and Co., Ltd., Hebburn-on-Tyne, Ian Ward Anderson Kirkwood, 72, Southwood Gardens, Gosforth, Newcastle-on-Tyne, 3, and Patrick Dunbar Ritchie, 16, Braintree Gardens, Gosforth, Newcastle-on-Tyne, 3.

Electrical insulators which consist of superimposed layers of a cellulosic base, such for example as paper or cloth, bonded with synthetic resins or other binders are open to the difficulty that they are liable to absorb moisture, since cellulosic materials, in general, are inherently hygroscopic. Even if the cellulosic insulator is impregnated with a synthetic resin the absorption of moisture by the fibres will not be wholly prevented and there will ultimately be a decrease in the dielectric strength, increase of power factor, and swelling of the insulator at the exposed ends of the fibrous layers. According to the invention, fibres of a vitreous substance, such for example as glass wool, preferably in the form of a woven fabric, are wound or wrapped in superimposed layers about a conductor or former, the conducting inserts being arranged between successive layers, and the interstices are filled with an insulating medium which, during the filling process, is in a liquid, semi-liquid or dissolved state or with an electrically insulating gas at or above atmospheric pressure and which will have a dielectric strength greater than that of air at atmospheric pressure.—*December 18th*, 1939.

FURNACES

515,883. May 14th, 1938.—OIL FUEL BURNERS, Henry Pittaway, Rosecroft, Old Hill, Staffordshire, and Ernest George Ward, Lee Hill, Mucklows Hill, Halesowen, Worcestershire.

The body of the burner is cylindrical, and has an opening A in one side for the admission of primary air under pressure. The rate at which air enters the body is controlled by a barrel valve B adapted to be moved angularly by a hand C projecting through an arcuate slot in the body. A sleeve D in the rear end of the body receives the fuel supply tube assembly which consists of a cylindrical fitting E to which fuel is supplied through a laterally extending union, a tube F extending through the body of the burner, an apertured nozzle on the front end of the tube, and a needle valve which controls the effective size of the aperture. An annular baffle or deflector G having a coned or chamfered peripheral surface of a diameter considerably less than the internal diameter of the body is fitted over the tube F within the burner body and is axially adjustable along the tube. Projecting inwardly and forwardly from the burner body in front of the baffle are two, three, or more blades or fins H of pear or equivalent shape. Each blade is carried by a stem which

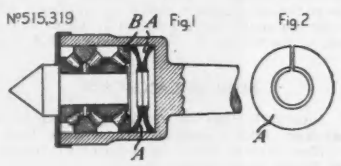


projects through and is rotatable in the body so that it can be adjusted angularly from outside. A sleeve J is slidably fitted over the front end of the body and its forward end is reduced in diameter to form a burner nozzle K. A ring L on the outside of the nozzle has in its inner edge a series of openings through which secondary air can pass to mix with the air and fuel issuing from the nozzle. When fuel and air are supplied to the burner the fuel is discharged from the jet and the air passing through the body is first deflected outwardly by the baffle G and is then given a swirling motion by the blades H. A certain proportion of the air stream is then deflected inwardly by the converging walls of the nozzle K and cuts across the fuel issuing from the jet and across the remainder of the air travelling along axially adjacent the tube F. The primary air and fuel leaving the nozzle are further mixed with secondary air drawn through the openings in the ring L. The position of the fuel jet relative to the nozzle can be varied by axial adjustment of the sleeve J and the baffle is also axially adjustable. The blades are individually adjustable angularly, so that the burner can be set to give good combustion with any fuel and any air pressure within reasonable limits.—*December 18th*, 1939.

MACHINE TOOLS AND SHOP APPLIANCES

515,319. May 30th, 1938.—LATHE CENTRES, Werner Roterberg, 40, Burghofstrasse, Düsseldorf 60, Germany.

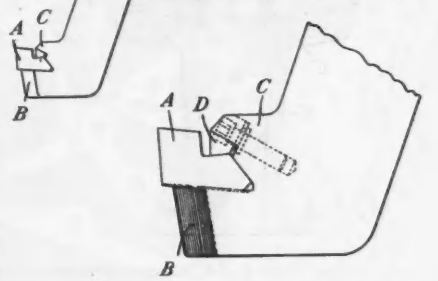
The rotating lathe centres described have dish-shaped resilient discs against which is supported the last outer ring of the roller bearing or the bush of the plain bearing. The discs A are preferably of conical or dome-shaped construction so that one outer edge rests against the last bearing ring B of the roller bearing and the opposite inner edge is supported against the



housing face or against a second spring ring. In order to produce a damping spring action suitable for the load occurring the disc is curved out or provided with weakened parts on one or both sides and in addition radial cuts are provided, whereby either flexible tongues are formed or other temporary variations in shape are produced. As shown in Fig. 2, it is sufficient in many cases to cut open the disc in order to give it the necessary elasticity.—*December 1st*, 1939.

515,438. June 1st, 1938.—TOOL HOLDERS FOR LATHES OR OTHER MACHINE TOOLS, the O. K. Tool Company, Inc., 233, Broadway, New York, United States of America.

The construction of this tool holder is clearly shown in the



accompanying drawing. It comprises an elongated body having formed at its forward end a bit receiving recess within which an L-shaped tool bit A is clamped. The body has a portion B underlying, and a portion C overlying the tool bit,

and between the two portions a wedge block D and the bit are mounted. The lower bit seating surface is inclined rearwardly and terminates an upstanding abutment surface. Both surfaces extend crosswise the holder so that the tool bit may be inserted from either side and adjusted laterally to the right or left. The upper surface of the tool bit slopes forwardly so that it is wider at its rear end than at a point immediately adjacent to the upstanding portion. This provides an abutment effective to resist inadvertent forward movement of the bit when clamped and also affords a semi-positive abutment for urging it rearwardly and downwardly during the manual operation of clamping the bit in its socket. The wedge is provided with screw clamp means. To receive the screw, the wedge is enlarged and a corresponding recess is formed in the body to receive it.—*December 5th*, 1939.

LOCOMOTIVES

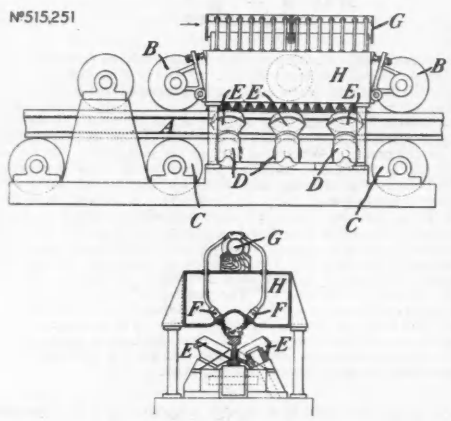
515,781. December 30th, 1938.—MOTOR RAIL CAR, Oswald Putze, 17, Agathstrasse, Breslau, Germany, and Linke-Hofmann-Werke Aktiengesellschaft, 12, Grundstrasse, Breslau, 6, Germany.

This invention relates to motor rail-cars provided with bogies and a power unit built into the bogie below the floor of the car body. The principal object is to provide an improved motor-bogie which can be easily fitted to or removed from the rail-car. The car, in which the power unit is built into the bogie below the floor of the car body, is characterised in that the bogie embodies the whole of the power plant and its associated parts including radiator, fuel tanks, starter battery, and the whole brake assembly, the parts being assembled together to form a complete unit located wholly beneath the plane of the floor of the body.—*December 13th*, 1939.

TRAMWAYS AND RAILWAYS

515,251. April 12th, 1938.—APPARATUS FOR THE HEAT TREATMENT OF STEEL RAILS, Christer Peter Sandberg and Oscar Fridolf Alexander Sandberg, 40, Grosvenor Gardens, London, S.W.1.

The rail A undergoing treatment is fed by rollers B, C on to supporting rollers D. In its travel the rail is guided by rollers E. The rollers B are mounted on swinging arms and are pressed into contact with the top of the rail by springs. Atomising nozzles F are fed through pipes from water mains G, supplied with water under pressure, and through openings with air from air

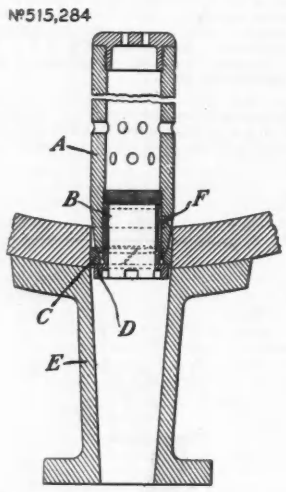


main H. The water and air meeting in the nozzles form sprays of atomised water. The pressure in the water main, which is at the side at which the rail enters, is greater than at the side at which the rail leaves. The guide rollers E are in the form of cups which catch the water flowing off the head of the rail, while that flowing off between the rollers is caught by catch plates. The superstructure carrying the air and water mains is supported on columns. By means of distance pieces or adjustable screw devices on the columns the height of the nozzles above the rail may be varied to suit different rail sections or to modify the angle and/or position at which the jets strike the surfaces of the rail head.—*November 30th*, 1939.

MISCELLANEOUS

515,284. June 14th, 1938.—SECURING TUBULAR MEMBERS IN APERTURES, John Thompson Water Tube Boilers, Ltd., and Gilbert Ashten Plummer, both of Ettingshall Engineering Works, Wolverhampton.

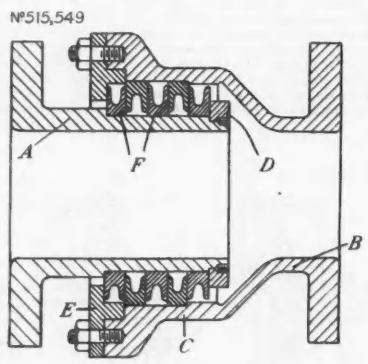
This invention relates to the securing of tubular members in apertures, and has for its main object the provision of improved



and simple means whereby such tubular members may expeditiously be rigidly secured in position while being capable of being readily removed and re-attached when desired. The accompanying drawings show one form of the invention applied to the connection of a strainer tube into a boiler blow-down outlet. In the operation of securing the strainer tube A in place, the end carrying the sleeve B and ring C is inserted into the aperture and the sleeve is screwed into the tube to cause its flange D to force the internally coned end of the ring over the coned end of the tube. The ring is thereby expanded against the wall of the aperture and rigidly secures the strainer tube in place. The manipulation of the sleeve may be effected by means of a bar passed through the tube E to engage in the sleeve, the end of the bar having projections adapted to engage in corresponding recesses formed in the internal wall of the sleeve. In order that the sleeve may not become detached from the strainer tube, during unscrewing, a set screw F is mounted in the latter to extend into a recess in the external wall of the sleeve.—*November 30th*, 1939.

515,549. June 3rd, 1938.—PIPE COUPLINGS, Andrew Marsden, and Component Fittings, Ltd., both of 68, Victoria Street, London, S.W.1, England.

Referring to the drawing, A and B are two sleeve members, the latter having a cylindrical portion C surrounding the end of the sleeve A. An annular chamber is thus formed. Flanges D and E are detachably mounted at the free ends of the parts A and C, so as to close partly the two ends of the chamber. A number of ring members F of rubber are placed inside the chamber as shown. The cross-section of each ring is substantially rectangular except for a deep peripheral groove at the outer surface, the rings thus being of about U-shaped cross-section. It will be seen that the chamber is filled throughout its length with interleaved rings, each alternate ring being in contact with the inner and outer wall. When the interior of the sleeve is filled with liquid under pressure, the fluid will enter the groove



of the innermost ring member exerting a pressure there by which the inner surface of this ring is pressed on to the outer surface of the sleeve, while the flange-like lateral portions of this ring are simultaneously pressed on to the flange D and the adjacent ring respectively. Any fluid penetrating, in spite of this application pressure, into the groove of this adjacent ring will exert there a similar action, by which its outer surface is firmly applied to the internal surface of the sleeve C, while the flange-like lateral portions of the ring are firmly applied to the outer faces of the adjacent two ring members. In this manner a number of sealing surfaces are produced, which are connected in series so as to constitute a reliable seal against any leakage of fluid. It will also be evident that the deformable nature of the packing rings will allow some limited relative movement of the connecting flanges without interfering with the reliability of the seal.—*December 7th*, 1939.

514,751. May 14th, 1938.—ALTERNATING CURRENT DRY CONTACT RECTIFIERS, Westinghouse Brake and Signal Company, Ltd., and Albert Leslie Williams and Leslie Ernest Thompson, all of 82, York Way, King's Cross, London, N.1.

An important, desirable quality in an oxide rectifier is that its electrical resistance in the reverse direction of current flow should be stable and not liable to appreciable creep or continuous change when voltage is applied. Experience indicates that this creep is dependent, amongst other conditions, upon the amount of free oxygen occluded in the oxide film or layer after its formation. According to the invention, a small quantity of the element boron either in the combined or uncombined state is introduced into the oxidising furnace during the heat treatment of the blanks. In carrying the invention into practice the boron, either uncombined or combined in the form of boric acid or borax, for example, may be introduced into the oxidising atmosphere in various ways. The boron or boron compound may, for instance, be injected into the oxidising furnace chamber in the form of vapour or a cloud of finely divided particles. Alternatively, a suitable receptacle or reservoir containing the boron or boron compound may be mounted within the furnace chamber, or the copper blanks, or their supports or carriers may be immersed in a suitable solution of a boron compound prior to the oxidising process. To ensure the uniform distribution of the added substance the furnace chamber employed is preferably provided with a non-porous lining, and with arrangements for effecting a circulation or agitation of the oxidising atmosphere within the chamber, for example, by means of an injected stream of air or oxygen. The addition of boron to the oxidising atmosphere in the case of copper oxide rectifiers is found to effect a considerable reduction in the initial reverse current, and the reverse creep at all impressed voltage, while the uniformity and crystalline structure of the cuprous oxide formed is much improved. Furthermore, the undesired formation of cupric oxide is reduced, only an extremely thin superficial layer of this compound being formed. Although the initial forward resistance of the rectifier element is increased by the use of boron to an extent dependent upon the amount of this substance employed, this disadvantage can be offset by reducing the thickness of the cuprous oxide film which is permissible owing to its superior quality and to the small amount of cupric oxide formed as above explained.—*November 16th*, 1939.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Chemical Engineering Group

Thursday, Feb. 29th.—Neville Hall, Newcastle-upon-Tyne. "Modern Gas Storage," S. Thomson.

Institution of Civil Engineers

Tuesday, Feb. 20th.—Great George Street, Westminster, S.W.1 "The Dragline Excavator," W. Barnes. 5.30 p.m.

Wednesday, Feb. 21st.—N. W. Assoc. 36, George Street, Manchester. "The Uses of Gunite," T. Whitley Moran. 6.15 p.m.

Tuesday, March 5th.—Great George Street, Westminster, S.W.1. "The Construction of Deep-Water Quays," A. C. Gardner. 5.30 p.m.

Institution of Electrical Engineers

Thursday, March 7th.—Savoy Place, Victoria Embankment, W.C.2. "Oil-less Metalclad Switchgear for Medium-Voltage A.C. Circuits up to 660 volts, Three-phase," H. E. Cox and L. Drucquer. 6 p.m.

Institution of Engineers and Shipbuilders in Scotland

Tuesday, March 19th.—39, Elmbank Crescent, Glasgow, C.2. "A Modern Approach to Building Technique," A. Miller. 6.30 p.m.

Institution of Locomotive Engineers

Wednesday, Feb. 28th.—Savoy Hotel, W.C.2. Annual Dinner, 6.30 for 7 p.m.

Institution of Naval Architects

Wednesday, March 13th.—Royal Society of Arts, John Street, Adelphi, W.C.2. Annual Meeting.

Institution of Mechanical Engineers

To-day, March 1st.—Storey's Gate, Westminster, S.W.1. "The Circulation of Water and Steam in Water-Tube Boilers, and the Rational Simplification of Boiler Design," W. Yorath Lewis and S. A. Robertson. 6 p.m.

Friday, March 15th.—Storey's Gate, Westminster, S.W.1. Lowe Gray Lecture, "Fifty Years of Marine Engineering," A. L. Mellanby. 6 p.m.

Institution of Production Engineers

Saturday, Feb. 24th.—Yorks. Section. Hotel Metropole, Leeds. "Some New Applications of Optics to Engineering," M. H. Taylor. 2.30 p.m.

Junior Institution of Engineers

To-day, Feb. 23rd.—39, Victoria Street, S.W.1. "The Application of Steam Propulsion to Road Vehicles," M. Harman Lewis. 6.30 p.m.

Friday, March 1st.—Sheffield Metallurgical Club, West Street, Sheffield. "Mechanical Properties in Relation to Design," H. W. Swift. 7.30 p.m.

Manchester Association of Engineers

To-day, Feb. 23rd.—Engineers' Club, Albert Square, Manchester. "Development in Design of Boilers and Boiler House Auxiliaries," A. Pollitt. 7.15 p.m.

Friday, March 8th.—Grand Hotel (Jubilee Suite), Aytoun Street, Manchester. Dinner and Dance. 7 for 7.30 p.m.

Royal Aeronautical Society

Tuesday, March 12th.—Institution of Electrical Engineers, Savoy Place, Victoria Embankment, W.C.2. "Aircraft Production," H. J. Pollard. 6 p.m.

PERSONAL AND BUSINESS ANNOUNCEMENTS

VICKERS, Ltd. announces that the Hon. R. H. Vivian Smith has been appointed a director of the company.

Mr. J. LAWRENCE has been appointed assistant manager of the Scottish branches of the General Electric Co., Ltd., and took up his duties at Glasgow on February 1st. Mr. Lawrence was for some years a member of the staff of the company's Birmingham branch, and was previously Midland manager of the Express Lift Company, Ltd.

CATALOGUES

JOSEPH CROSFIELD AND SONS, Ltd., Warrington. Brochure dealing with the properties and uses of "Sorbail" silica gel.

MOLLART ENGINEERING COMPANY, Ltd., Kingston By-Pass, Surbiton, Surrey. An illustrated price list of universal ball joints.

HIGGS MOTORS, Ltd., Witton, Birmingham. New catalogue sections on squirrel cage low starting current induction motors and motor generator sets.

J. H. FENNER AND CO., Ltd., Hull. New edition of the firm's catalogue on standard V rope drives which also includes much useful design data.

MONITOR PATENT SAFETY Devices, Ltd., Kings Road, Wallsend on Tyne. A leaflet on the "Monitor" pressure alarm with indicator panel combined.

STERLING FOUNDRY SPECIALITIES, Ltd., London Road, Bedford. Catalogue No. 50 of moulding boxes, pattern plates, core plates, and other foundry equipment.

RUSTON AND HORNSBY, Ltd., Lincoln. A publication illustracting and describing in detail the company's marine oil engines and some of the ships in which they are installed.

WILLIAM ASQUITH, Ltd., Halifax. New catalogue of machine tools for aircraft production including profiling machines, drilling machines, milling machines, and boring machines.

FOSTER YATES AND THOM, Ltd., Canal Foundry, Blackburn. Booklets on "Fostayates" Lancashire boilers, double return tube boilers, economic boilers, chemical plant, and rubber plant.

EVERSHED AND VIGNOLES, Ltd., Acton Lane Works, Chiswick W.4. Brochure on the Evershed-Midworth distant repeater for transmitting information to a distance, and for controlling distant apparatus.

BENJAMIN ELECTRIC, Ltd., Brantwood Works, London, N.17. A booklet illustrating a number of lighting installations carried out by the firm and a leaflet on the "White Coolicon." a new unbreakable light shade.

CROSSLEY-PREMIER ENGINES, Ltd., Sandiacre, near Nottingham. A brochure illustrating and describing in some detail the construction of vis-a-vis type horizontal heavy duty oil engines in powers up to 3000 B.H.P.

BRITISH MECHANICAL PRODUCTIONS, Ltd., 79A, Rochester Row, London, S.W.1. Catalogue of "Clix" electrical and radio accessories, including plugs, sockets, adaptors, switches, valve-holders, terminals, connectors, &c.

BRITISH INSULATED CABLES, Ltd., Surrey House, Victoria Embankment, London, W.C.2. A sample and particulars of "Pernax" flexible insulating material which is tough, flexible, waterproof, corrosion resisting, and easily moulded.

ENGLISH ELECTRIC COMPANY, Ltd., Queens House, Kingsway, London, W.C.2. The following publications:—"Machine Tool Lighting Transformer"; "Diesel Engines"; "Synchronous Induction Motors"; "Combination Fuse Switches"; and "Portable Transformer for Safety Handlamps."